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THE SMALLEST OF THE CENTURY PLANTS[1]

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MISSOURI BOTANICAL GARDEN

SELECTION of these particular plants from the very large number that have occupied my attention for the last ten years is based on a recognition of the fact that it is extremes—the largest and smallest,

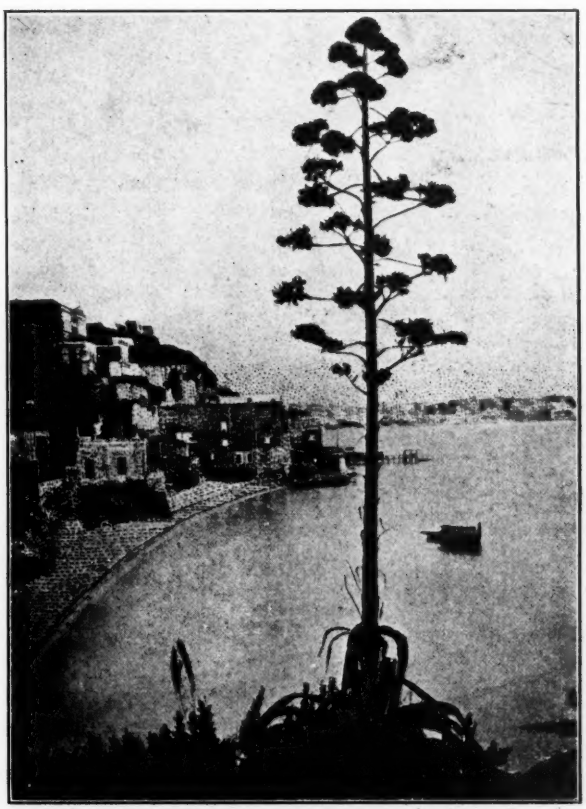

Fig. 1. About the Mediterranean.

[1] A lecture before the Academy of Science of St. Louis, delivered October 17, 1910.

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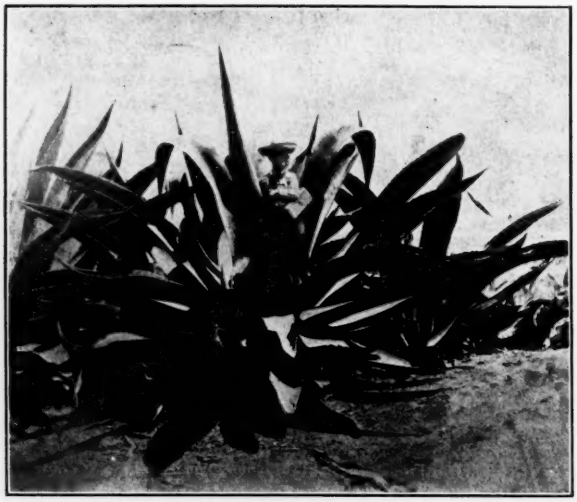

FIG. 2. GROWN FOR PULQUE.

the best and the worst—rather than ordinary or average things which attract human interest. The present very short communicaion may be called a vest-pocket account of the vest-pocket edition of the century plant. The use of this name, however, is not quite accurate, for the century plant properly is that large *Agave,* standing as the type of its genus, which was introduced into Europe not so very long after the discovery of the new world by Columbus, which has now become thoroughly naturalized about the Mediterranean, and which in northern

FIG. 3. THICK AS A MAN'S BODY.

countries, even when protected against the winter, literally takes the larger part of a century for its development. In the popular mind the idea of a century plant also includes the enormous species grown for pulque on the elevated plains to the south of the City of Mexico, and even larger plants of the same type, each of them reaching the weight of a ton or more, and sometimes producing a flower stalk nearly as thick as a man's body. In this sense, then, the name century plant becomes nearly equivalent to the Haitian name maguey, as now applied in Mexico, where the Spaniards introduced it in place of the Aztec name for these plants—metl. My use of the word, then, is rather as an equivalent of the botanist's generic name, *Agave,* than of this particular designation of a part of its species.

FIG. 4. GIANTS AND PYGMIES.

A comparative notion of the size of these giants of the genus and its pygmies, with which I am here concerned, is afforded by a photograph of the latter, taken by the side of two of the fruiting branches of a mammoth West Indian species which I have hanging to a chimney breast in my study. The larger of these dwarfs is no larger than one's fist, and the smaller scarcely equals the seed-vessel of a great maguey.

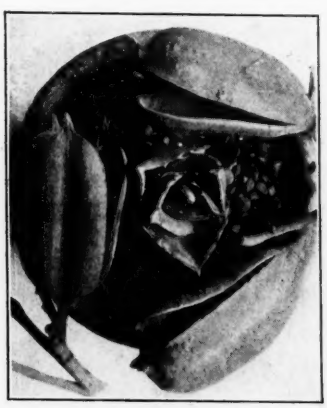

FIG. 5. SCARCELY EQUALS A SEED VESSEL.

The larger of these species was first discovered by the international survey of the boundary between Arizona and Sonora, more than half a century ago, and although it is abundant on the ragged mountains of the boundary region, it has been collected very few times so far as yet known, since then: ten years ago near the one hundred and twenty-ninth boundary monument in the Pajarito Mountains by myself when I was looking up typical material of some of the species first made known through the International Boundary Survey; last year when

FIG. 6. IN THE PAJARITO MOUNTAINS.

Mr. J. C. Blumer collected it in the same region; and this season when Mr. James H. Ferriss found it in the Guija Mountains. The little plant here illustrated is the one sent in by Mr. Blumer, which in transit had begun to develop a flower stem and which, flowering in May of last year and fruiting in the following summer, has given the first opportunity for a botanist to observe these phenomena and to see in perfection its diminutive flowers which, scarcely three quarters of an inch long, led its describer, Dr. Torrey, to name it *Agave parviflora.*

Like those of many agaves and yuccas and some other genera the solid stem and thick leaf bases of this plant contain a saponifying substance which has won for it, as for these various plants, the name amole, or soap-weed. Its thick, rounded leaves, like those of a comparatively few other species in the genus are beautifully marked by irregular stripes of pure white, due to bits of cuticle torn from other leaves as the central bud or cogollo opened. When Dr. Engelmann

presented his classical notes on *Agave* to the academy thirty-five years ago, he stated that the occurrence on the margins of these leaves of detaching threads above and little prickles below was, so far as known, unique in the genus, and except for a very few close relatives of this plant the statement still holds true.

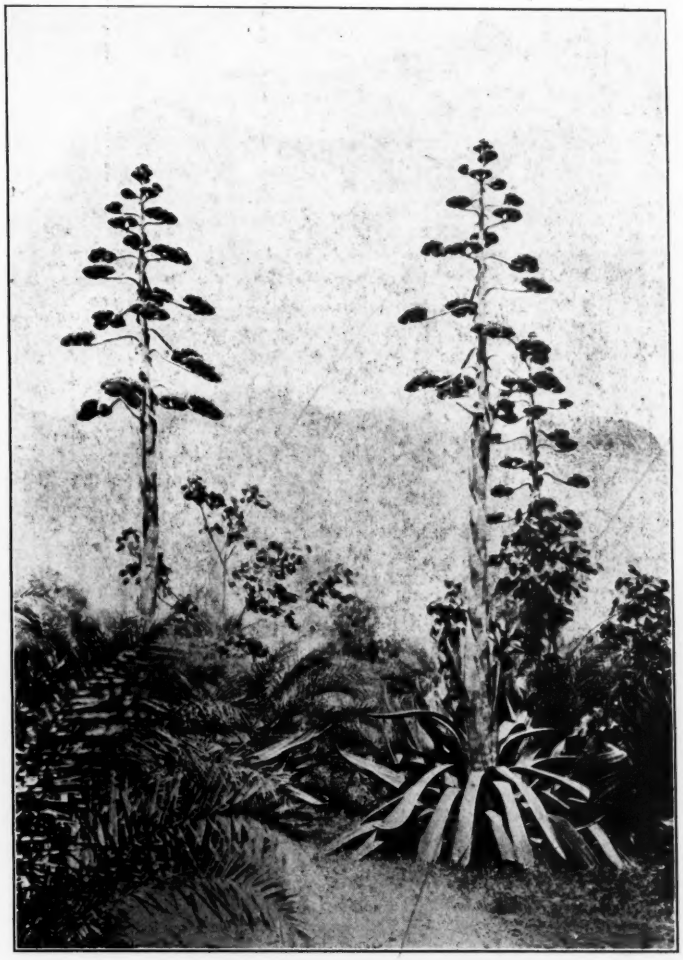

FIG. 7. CANDELABRUM-LIKE PANICLES.

The main kinds of *Agave* fall into two recognized classes: one, illustrated by the true century plant and the pulque magueys, bears flowers in candelabrum-like panicles; the other, like the lechuguilla, has its flowers disposed mostly in pairs along a wand-like spike. An effort has been made to separate these latter from *Agave* under the generic name *Littæa,* but this has not met with general acceptance and in fact there are puzzlingly intermediate species, as, for instance, the *Littæa*

FIG. 8. A WAND-LIKE SPIKE.

characteristic of the Grand Cañon, and a garden *Littæa* which many years ago I named in commemoration of the accurate student of this group of plants, Engelmann.

Agave parviflora is clearly a *Littæa,* with its flowers rather loosely disposed along the upper part of an inflorescence wand scarcely thicker than a goose-quill, but its flowers by no means grow in pairs, though each short main stalk forks at the beginning. On the contrary, clusters of six or eight flowers—of which all but two or four commonly fail to develop—are borne by its forked primary branches, a study of which is capable of throwing much light on the reduced rather than primitive typical twin flowers of the littæas.

As with all of the agaves that have been studied so far, this species matures the stamens and pistils of a given flower at different times. The flowers, which open early in the morning, quickly protrude their stamens and shed their pollen immediately, but the style is then no

FIG. 9. CHARACTERISTIC OF THE GRAND CAÑON.

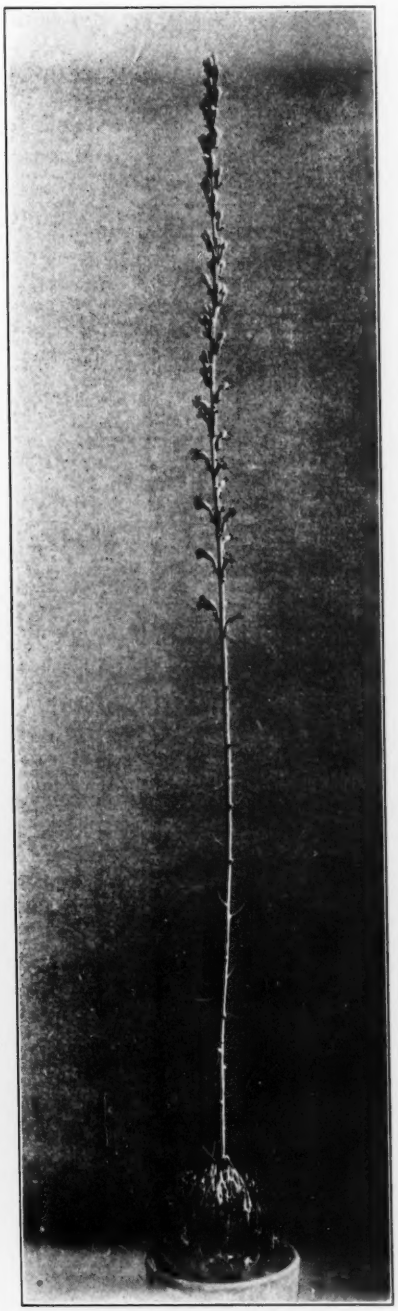

FIG. 10. *Agave parviflora.*

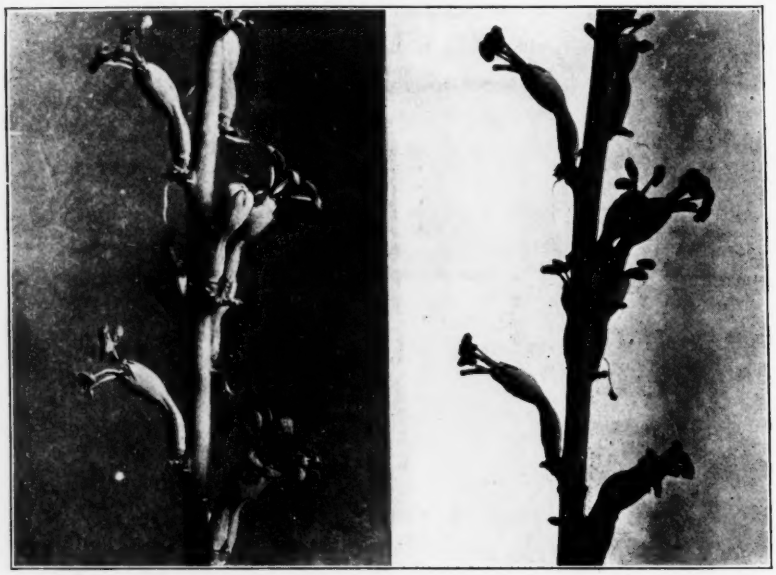

FIG. 11. EARLY IN THE MORNING. FIG. 12. THE NEXT MORNING.

longer than the perianth and its stigma is not receptive for pollen. By the next morning, however, the style has reached the stamen in length, though it is still unreceptive. After two days, the stamens have shriveled and drawn out of the way and the stigmatic lines have become fleecy and moist, indicating receptivity. Though scentless, and greenish white, rather than brightly colored, the flowers secrete an abundance of nectar which with the proterandry points to cross pollination by the aid of insects.

When Arthur Schott collected the type specimens of *Agave parviflora* it was in fruit, though the upper part of some of the specimens still retained a few unopened buds, and a few sterile, dried-up flowers were included in the collection. My own observation of the plant in the field was also made during its fruiting season and I am not aware that its fresh flowers have ever been seen except on this specimen. The main structural characters of the flowers were accurately made out by Engelmann and are preserved in his perfectly prepared dissections, but the contribution which this little specimen has made to a correct understanding of their shape and proportions is clearly shown by a comparison of these type flowers with its own.

Almost if not quite as small as *Agave parviflora* are two other species in many respects closely similar to it: a little plant found in northern Mexico on the Lumholtz expedition, which Mr. Watson named, after its discoverer, *Agave Hartmani,* and an unnamed plant of similar habit but with a short perianth tube equalled in length by the perianth lobes, which Professor Toumey found eighteen years ago

in the Pinal Mountains of Arizona. In the course of my study of this group of agaves with thread-margined leaves I have also encountered a garden plant of about twice the dimensions of *A. parviflora* and with differently shaped leaves, which has been grown under the name of *parviflora* but which is not unlikely to prove more closely related to the thread-bearing amoles of central Mexico. The prickly margin and its replacement by detaching threads which characterize *parviflora* are particularly well shown on the juvenile foliage of offsets from this plant.

The other and still smaller dwarf first came into the market under the trade name *Agave pumila*—given because of its minute size—about thirty-five years ago, the earliest mention of it that I find being in a catalogue published in 1877. No record is available as to the source of the plants then or now in commerce, though I have been told that a collector of such plants has seen it in the Andes of Colombia. Like many other agaves, this produces offsets freely and is now rather extensively cultivated. It was named in 1888 by Mr. Baker, who stated that his plant—about as large as the one here shown—had not increased appreciably in size for the eight years during which it had been cultivated at Kew. Though I have no doubt that it grows to something more than this walnut-size, I shall be surprised if it ever reaches the proportions of *parviflora*. It is known in botanical literature only from the original description. Its very thick leaves have short, sharp end-spines, decurrent on the margin in a dried line of the same texture as the little marginal prickles. From the fact that this margin was not continuous, Mr. Baker was led to range *Agave pumila* in his submar-

FIG. 13. JUVENILE FOLIAGE.

FIG. 14. LINED WITH DARK GREEN.

ginate series, which brings this, the least of all agaves, close beside the greatest of its congeners, the gigantic pulque magueys. It would be surprising if, when its flowering is made known, *pumila* were found to develop a diminutive candelabrum inflorescence; in fact, this is not to be expected. A character shown by this specimen and, so far as I know, never before noted publicly, is that the backs of its leaves are finely lined with dark green on a lighter background. Though generalizations are unsafe, I may say that in the course of an exhaustive study of all of the agaves that it has come my way to see I have thus far seen such lining only on littæas of the horny-margined section, like the lechuguilla—the marking being due, in fact, to the development of what may be called an emergency water tissue on the lower side of the leaves, the darker green stripes marking points at which the full chlorophyll-bearing tissue comes out to the epidermis and the water tissues developing more or less chlorophyll according to differing conditions of drought and exposure to light. There is every reason to believe, therefore, that when it flowers *Agave pumila* will produce a littæa spike and flowers similar to, if not so large as, those of *A. lechuguilla.*

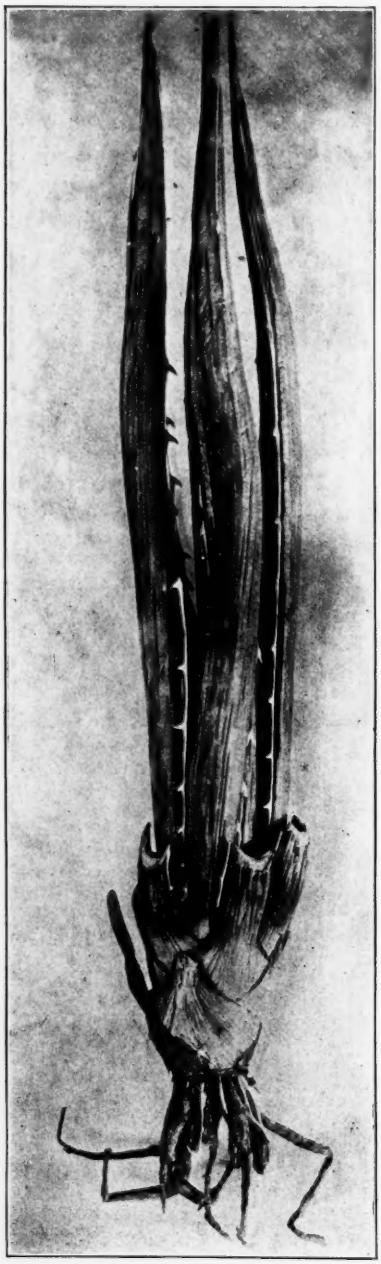

FIG. 15. THE LECHUGUILLA.

No agaves are known south of the isthmus of Panama except one of the West Indian panicled series which has developed in the Venezuelan coast region, and a little-known plant of the Andes, near Lima, which is evidently a littæa, though of a mezcal series, quite unrelated to

the horny margined group. It need, therefore, be little more surprising if *Agave pumila* of the latter group is found to be really at home in the Andes, than that another littæa type should be found in the same exile, though relatives of the latter are characteristic of southern Mexico while known marginate species are more northern.

EUTHENICS AND EUGENICS

By Dr. C. B. DAVENPORT
COLD SPRING HARBOR, L. I.

OF late years the reading, thinking public has been awakened to a realization that sickness, poverty and crime are great and perhaps growing evils. It does not seem right that there should always be about 3 per cent. of our population on the sick list, that our alms houses should support over 80,000 paupers, not to mention the hundreds of thousands that receive outdoor relief or are barely able to earn a living; and that there should be 80,000 persons in prison. It ought not to be that the nation should have to support half a million insane, feeble-minded, deaf and blind and that a hundred million dollars should be spent annually by institutions in this country for the care of the sick, degenerate, defective and delinquent. It is a hopeful sign of the times that people are asking: "What can we do about it? What is the cause and what the remedy for this state of things?"

The answers to this inquiry take two general trends. One set of reformers urges that the socially unfit are the product of bad conditions and that they will disappear with the establishment of some modern Utopia. The other set of reformers urges that the trouble lies deeper—in the blood—and is the outcome of bad breeding; the trouble will disappear if marriage matings are made more wisely.

The point of view of the first set of reformers may be made clear by some quotations from their works. Thus Henry George, Jr., in his book, "The Menace of Privilege," after stating that there is an increase of insanity, suicides and crime asks: "From what does all this proceed?" and he replied: "Poverty. It means privation . . . insanity, suicide, crime." Mrs. Ellen H. Richards has stated the position of these reformers so well that I am constrained to make numerous quotations from her valuable book entitled "Euthenics"—a name that may well be applied to the point of view that is contrasted with eugenics. She says: "Of all our dangers that of uncleanliness leads" (p. 19). "The necessity of judicious, wholesome food is paramount" (p. 22). "Mr. Robert Hunter says: 'Perhaps more than any other condition of life it [food supply] lies at the door of the social and mental inequalities among men'" (p. 23). "A strong, well man, whose work is muscular and carried on in the open air, as is that of the farmer and of the fisherman, will have the power to assimilate almost anything" (p. 24). "Just as soon as the individual fully realizes that he himself is to blame for his suffering or his poverty in human energy, he

will apply his intelligence to the bettering of his condition" (p. 26). "Why are men and women so apathetic over the prevalence of disease? Why do they not devote their energies to stamping it out? For no other reason than their disbelief in the teachings of science, coupled with a lingering superstition that, after all, it is fate, not will power, which rules the destinies of mankind" (p. 28). "There is no greater evil than the congestion of streets and buildings" (p. 48).

In apparent contrast to the euthenics view of the importance of conditions is the eugenics view of the importance of blood. Taking an extreme case, a child is born an imbecile and neither the best of nutrition, the most scrupulous cleanliness, the purest air and sunshine, nor the best of physical and mental training will make anything else out of him. Imbecility can not be cured; in most of its forms it is a necessary result of the nature of the parental mating. It is a defect due to a patent or latent defect in both of the paternal germ plasms. The imbecile is an imbecile for the same reason that a blue-eyed person is blue-eyed.

Lest you have not heard where a blue-eyed child gets its eye color, let me recount the story. Brown eyes are due to a brown pigment laid down in the iris; blue eyes are due to a lack of such pigment. When both parents are brown-eyed the children get the tendency to form iris pigment from both sides of the house, and the condition of the pigment is said to be duplex. If the children get the tendency from one parent only, they still have brown eyes, but the condition is said to be simplex. If both of the parents lack brown eye-pigment, that is proof that the power of producing it is absent from their germ cells. Now, what is absent from the germ cells can not be transmitted, consequently, two parents lacking brown in the iris (blue-eyed) will never have children with brown eyes, but only with blue eyes. If both parents have brown eyes simplex, then one in four of the children will have blue eyes. If one parent has simplex brown eyes and the other has blue eyes, one half of the children will have blue eyes. But, if in both or either one of the parents the brown iris pigmentation is duplex all of the offspring will have brown eyes.[1]

TABLE OF MATINGS AND OFFSPRING—EYE COLOR

One Parent	Other Parent	Offspring	
PP	PP	PP, PP.	All with pigmented iris (brown-eyed).
PP	Pp	PP, Pp.	All pigmented, but half simplex.
PP	pp	Pp, Pp.	All pigmented and all simplex.
Pp	Pp	PP, Pp, pP, pp.	¼ duplex pigmented; ½ simplex; ¼ unpigmented (blue-eyed).
Pp	pp	Pp, pp.	½ simplex; ½ unpigmented (blue-eyed).
pp	pp	pp, pp.	All unpigmented (blue-eyed).

[1] These different cases of inheritance fall into six groups as in the following table, in which PP stands for duplex pigmentation, Pp for simplex pigmentation and pp for lack of pigmentation.

Now, it will be observed, says the extreme eugenist, that these rules hold no matter whether the children develop in the city or in the country, in moist climate or dry, under conditions of good nutrition or of poor. And what is true of eye color he would maintain is true for skin and hair color, for stature, for abnormal fingers and toes, for diseases of various sorts. Even criminals, like poets and artists, are born and not made. It is not poor conditions that create insanity, but poor blood; not the germ of tuberculosis, but non-resistant protoplasm that causes death from consumption.

Thus the two schools of euthenics and eugenics stand opposed, each viewing the other unkindly. Against eugenics it is urged that it is a fatalistic doctrine and deprives life of the stimulus toward effort. Against euthentics the other side urges that it demands an endless amount of money to patch up conditions in the vain effort to get greater efficiency. Which of the two doctrines is true?

The thoughtful mind must concede that, as is so often the case where doctrines are opposed, each view is partial, incomplete and really false. The truth does not exactly lie between the doctrines; it comprehends them both. What a child becomes is always the resultant of two sets of forces acting from the moment the fertilized egg begins its development—one is the set of internal tendencies and the other is the set of external influences. What the result of an external influence —a particular environmental condition—shall be depends only in part upon the nature of the influence; it depends also upon the internal nature of the reacting protoplasm.

I have two dogs, a fox terrier, and a bird dog. They come upon a wounded bird. The terrier sniffs at it and passes it by, but the retriever picks it up and carries it for a time in its mouth. Is it simply the wounded bird that determines the retriever's action? Clearly no, since the bird did not cause the same response in the terrier. Is it alone the nature of the retriever that determined the carrying; no, since he would not similarly carry a stone. The result is due to the *bird* acting on the peculiar *constitution* of the retriever. So, in general, any human behavior is the resultant of the specific stimulus and the specific nature of the reacting protoplasm. Development is a form of behavior and how a child shall develop physically, mentally and morally is determined not by conditions alone, not by blood alone, but by conditions *and* blood; by the nature of the environment and the nature of the protoplasm.

This principle may be applied generally and it holds true even in diseases. It is an incomplete statement to say that the tubercle bacillus is the cause of tuberculosis, or alcohol the cause of delirium tremens. Experience proves it, for not all drunkards have delirium and not all that harbor the tubercle bacillus die of consumption—else we must all

die of that disease. No, the causes of death as given in the health reports or census bulletins are not the real causes. All of these results are due to an inciting condition acting on a susceptible protoplasm. The real cause of death of any person is his inability to cope with the disease germ or other untoward condition.

The fact that of all occupations of females that of servant shows the highest death rate from consumption does not imply that this occupation is extra-hazardous to the lungs or to body-resistance rather than that servants are largely Irish (who as a nation lack resistance to tuberculosis) or that they are below the average in mental and physical development, including disease resistance.

What is true of consumption is true of various diseases that are commonly thought not to be due to germs, but to conditions of life. Insanity is one of these. Mr. A. goes insane; we explain that it is because of business losses or overwork. But there are a lot of us who have severe losses or who work hard and show no signs of nervous breakdown. It would be more accurate to say A. went insane because his nervous machine was not strong enough to stand the work put upon it. Insanity (except perhaps paresis and the so-called "alcoholic psychoses") rarely occurs except where the protoplasm is defective. Also epilepsy, which is so often ascribed to external conditions, is, like imbecility, determined chiefly by the conditions of the germ plasm; and the trivial circumstance that first reveals the defect is as little the true cause of the defect as the touching of the button that opens an exposition is the motive power of the vast engines.

The variations of density in the geographic distribution of a disease, upon which climatologists lay so much stress, does not always warrant the popular interpretation of the facts. A heavy incidence of disease in any county does not always mean unfavorable environment. I have plotted the distribution of imbeciles received by an institution in a small state. The ratio of incidence of this condition to the entire population is high in some counties (chiefly *rural*) and low in others, due to the presence or absence of foci of the defect. Similarly the varying rate of deaf-mutism is determined by the density of defective germ plasm. So, also, despite its fine climate, the rising generation in California is characterized by diseases of the mucous membranes, because a generation ago much weak protoplasm was attracted to this state as a sanatorium. No, blood is as important a factor in determining the occurrence of disease as climate.

Crime, which the euthenist finds so related to conditions, proves to be, like disease, a resultant of conditions and blood. Only so can we explain the pedigree trees of criminal families like the Jukes and the Zeros. Tactful, firm, sympathetic, just treatment can do much to reform juvenile delinquents, but if the moral sense and balance are

absent the treatment will avail little or nothing. Upon the children of the "Zero" family the priest-school was without effect. The time and pains required for reformation will, in any case, depend on innate qualities of the delinquent.

In respect to talent the importance of both blood and training is generally recognized. Many "lightning calculators" and mathematical prodigies are born and are not at all the product of training, yet training improves the gift for mathematical abstractions. In the realm of vocal and instrumental music the same is true. Even the *prima donna* must be trained. Though the Bach family contained musicians for eight generations, and twenty-nine eminent ones assembled at one family gathering, still training no doubt added to the value of their performances, at the same time that their inborn capacity rendered them apt scholars.

The objection has been raised, as we have seen, to recognizing that heredity has any considerable importance in determining unfavorable results, on the ground that it is a pessimistic and fatalistic doctrine. Euthenics, on the other hand, offers opportunity to do something to improve a person's condition. Apart from the fact that the truth must be faced whether pleasant or not, the contention can not be too strongly urged that improvement of conditions is only palliative, while improvement of blood is essential to permanent progress. Our only hope, indeed, for the real betterment of the human race is in better matings. If any one doubts this let him ask the agriculturalist. Let him ask the Florida orange grower, who no longer fears the frost, if heredity is a "terrible" fact; let him ask the "dry farmer" of Montana, who cultivates his special varieties that require little rain, if heredity gives him the blues; let him ask the breeder of improved Holstein cattle whether he would, if he could, annihilate the fact of transmission of qualities; they would laugh in your face; they would assure you that heredity is their main reliance and their most precious tool. So to the eugenist heredity stands as the one great hope of the human race; its savior from imbecility, poverty, disease, immorality. But, to be effective, the available salvation must be accepted. By some means or other the principles of eugenics already known, and those which studies now being undertaken will surely reveal, must be applied in marriage selection. To-day, marriage is controlled imperfectly, crudely, by social ideals. Incest, cousin marriages, the marriage of defectives and tuberculous persons, are, in wide circles, taboo. This fact affords the basis for the hope that, when the method of securing strong offspring, even from partially defective stock—and where is the strain without any defect?—is widely known, the teachings of science in respect even to marriage matings will be widely regarded and that in the generations to come the teachings and practise of euthenics will yield the greater result because of the previous practise of the principles of eugenics.

THE METEOROLOGY OF THE FUTURE[1]

By Professor CLEVELAND ABBE

U. S. WEATHER BUREAU

AFTER some introductory remarks by Dr. Finley, president of the College of the City of New York, Professor Abbe said:

I think myself specially honored by these kindly words from the president of the College of the City of New York. You all know how thoroughly that noble institution has, during the past sixty years, entrenched itself in the hearts of our citizens, and you know what Dr. Finley is doing to carry its work forward. To it many of us owe those youthful inspirations that have determined our careers in maturer life. It is always a delight to me to recall the years 1851–1857 when at that college I studied the foundations of modern physical science; mathematics under Docharty, descriptive geometry under Koerner, mechanics under Nichols, physics and chemistry under Gibbs. Not to speak of those other revered instructors, Owen in Latin and Greek, Anthon in history, Duggan in architecture, Roemer in French. Each one of these is still to me a living inspiration. Such men do not die so long as their words and lives continue vividly before us. It was worth living in those days to have listened to the brilliant diction and witnessed the successful experiments of Robert Ogden Doremus in his lectures on the Nebular Hypothesis. These admirable educators dealt with questions that I have gradually come to see are intimately associated with our atmospheric problems, though they themselves probably did not think of such connection at that time. It may be said that every course of study then pursued at that college has proved useful in the modern development of meteorology. Of course this is equally true of the studies now pursued at Columbia University. May both that college and this university in the future send forth many meteorologists and others to benefit our city, our nation and our science.

My task to-night is to be as difficult as the problem proposed of old by Pharoah to Joseph. I am to tell you a dream of the future of science and also the interpretation thereof.

In the preceding nine lectures, my colleagues have given you some idea of the present state of our knowledge of the atmosphere. Possibly you may have already suspected that we know very little about the air in which we live. You must not think less of the honest scholar when

[1] A public lecture, illustrated with experiments, at Columbia University, March 16, 1909.

he assures you that what we really *know* beyond all peradventure is as nothing compared to the unknown ocean of truth still to be explored. I trust that you will sympathize with my enthusiasm over the study of the atmosphere. Does not the wonderful glory of a sunset sky stimulate one to study its causes and to discover what its clouds and colors have to do with the weather of to-morrow? Who can watch the approach or recession of a thunder-storm and not be impressed with the dreadful majesty of its appearance? We may dream of the immensity of space as we contemplate the star-lit sky at night, for the stars are far, far away and men are always dreaming of them—but we can not merely *dream* of the clouds, the weather and the storms; the atmosphere is too near at hand for mere dreams; it forces us to action; it is close to us; we are in it and of it. It rouses us to both study and do; we must know its moods and also its motive forces; we must conquer it in our struggle for existence. Now that our aeronauts Orville and Wilbur Wright have learned to fly, we must learn to utilize the air just as the mariners have learned to utilize the winds and avoid the storms.

In the days of Columbus (1437–1514), Drake (1540–1596), Dampier (1652–1715) and Halley (1656–1742) the mariner long ago knew of the trade winds and the seasonal monsoons and the prevailing westerlies, and took advantage of them. It took two more centuries to acquire a knowledge of whirlwinds as they advance over the globe; and only the present living generation of men has seen the growth of national and local weather bureaus in every part of the civilized globe established to forewarn mariners of storms, or landsmen of rain and wind, frosts and blizzards. We are not yet able to speak of such weather forecasts as anything more than probabilities or indications, they have not yet become certainties, but surely you are all convinced that already, even in the present imperfect state of our knowledge, the meteorologist is worthy to be recognized as a benefactor of mankind.

Has any community in this country or in the whole world profited by the steady daily watchfulness of such a weather bureau more than this very city of New York? Thousands of your law cases are decided annually on the testimony of official weather records. Your business men are forewarned of every storm. Whenever current weather conditions threaten misfortune to any special branch of industry you make a hundred inquiries by telephone, telegraph or personally, asking for details as to what is going on overhead. Your morning papers and your evening papers are consulted by every one for the weather forecasts; your business matters are arranged in accordance with the conviction that one can not afford to neglect this little item of information, any more than he can afford to neglect ordinary insurance, even though he knows that there is a chance for an occasional mistake. The daily weather map is distributed as widely as possible for the benefit of all

and is a splendid educator. This map gives us the facts, even though the best of us often fail to perceive what they mean and what they foretell.

And right here I must remind you that this system of daily telegrams, with its maps and forecasts owes its origin and subsequent perfection almost entirely to the citizens of the city and the state of New York. New York City has always been the home of meteorologists, just as our bay with its sailing vessels and steamships has always been filled with the bravest of sailors and navigators. Others besides Hudson and Fulton, Stevens and Ericsson, Cyrus Field and Wm. H. Webb have helped to make the fame of New York and the Hudson.

Here lived W. C. Redfield, whose busy life as a merchant did not prevent him from collecting the logs of ships and studying all the characteristics of storms at sea. For forty years he devoted his leisure hours to this work, publishing one research after another from New York City, until the whole world understood that hurricanes, cyclones and typhoons are whirlwinds, revolving and progressing as a whole, moving slowly along paths that carry them from equatorial toward polar regions; that our own hurricanes move westward and northward over the West Indies into our south Atlantic and gulf states and thence north and east along our coasts to northern Europe.

Here lived Elias Loomis, teaching meteorology and astronomy for many years as a professor at the New York University, and studying the storms of the land.

Here lectured James P. Espy, a native of Pennsylvania, who, with inimitable eloquence and enthusiasm defended his great discoveries that a cloud must contain the heat that was originally consumed in the evaporation of the water; that the moist air by rising had cooled by expansion down to its dew point; that the condensation into cloud caused latent heat to be set free.

Here, and in the northern part of our state, we had B. F. Hough at Lowville, who gave us our best studies of the New York climate and our first stimulating reports on the importance of forestry.

Our dear New York, the youthful city of a century ago, was the home of Professor Samuel F. B. Morse, artist and inventor, whose enthusiasm triumphed over the difficulties in the way of perfecting the electro-magnetic telegraph, and made it possible for our great national weather bureau to carry on its work expeditiously and economically.

At Albany Professor Joseph Henry, the father of the electro-magnetic telegraph, maintained the importance of the study of the atmosphere. In 1847, when he was called from Princeton to become the secretary and brains of the Smithsonian Institution in Washington, he immediately arranged with the telegraph companies for telegrams, displayed them on daily weather maps and demonstrated the possibility of forecasting storms and weather.

Greater New York, that is to say the Brooklyn of sixty years ago, was honored as the residence of Ebenezer Meriam, "the sage of Brooklyn Heights," a manufacturer, but also special correspondent and associate editor of the New York *City Commercial,* in whose columns, about 1850, he began to publish his weather forecasts compiled by using all the information at his disposal, especially the telegrams of weather conditions in distant places. His forecasts of "heated terms" and "cold terms" not only prepared the general public to believe that weather could be predicted, but had a special influence on one young student just entering your City College, whose scrap book of 1850 still contains the history of early events that stimulated his boyish imagination and aspiration. Meriam was but carrying out single-handed the ideas urged by Redfield and Loomis, Espy and Henry, looking to the formation of a government weather bureau. The rule that weather changes move eastwardly for several days in succession was utilized by New York business men even before Professor Joseph Henry announced from Washington the general result of the labors of James H. Coffin, of Ogdensburg, N. Y. It was Professor Coffin who during the years 1838–1840 published our first American meteorological magazine and eventually compiled a great work on the winds of the globe, demonstrating that in these latitudes (between 30 and 60 degrees north) there always is a strong west wind high above the ordinary layers of clouds, that apparently explains the eastward drift of our storms.

The complete mechanism of the atmosphere was clearly explained by William Ferrel in 1858, so that finally, in May, 1868, when our country was rapidly recovering from its terrible internal dissensions, a young astronomer from New York, a graduate of your City College, who had been revolving in his mind all these teachings of his elders, and had from boyhood been observing the clouds and winds and weather, submitted to the Chamber of Commerce of Cincinnati his project of weather forecasts for the benefit of that city. He was ably supported by the officers of the famous astronomical observatory, by the citizens of the "queen city of the west," by her newspapers and her telegraph authorities. You will agree with me that he was within bounds when he wrote from Cincinnati to his parents in New York: "I have started a work that the country will not willingly let die." This was the work that in the hands of General Albert J Myer, of Buffalo, has brought such fame to our country and city.

Although the study of science and the pursuit of research is most fascinating and elevating, yet no man should be satisfied therewith. It is right to be content from day to day, but never satisfied. The highest type of man is he who seeks to be most useful to his fellow men. It is the duty of every citizen of this republic to attain the highest usefulness

that he is capable of. He may temporarily devote himself to acquiring knowledge or money; to perfecting art or inventing machinery; he may apparently devote his whole life to some mercantile pursuit, but if he be true to his own conscience, his ultimate hope must be to benefit his country and mankind. Anything else less than this dies; just as he himself must die; it dies with him. Patriotic philanthropy can alone afford a man the comfortable assurance that his life has been well spent. No one founds a hospital, a library, a museum, a park or a university, for purely selfish ends; he knows, and he takes pleasure in knowing, that the whole community will be benefited, and that future thousands will thank him for that which otherwise would have been unattainable to them. He has given to his money and his life their maximum power for good.

At this moment Columbia University surrounds us with this group of noble buildings, testifying to the wisdom of many wealthy men. The names of the best of New York are inscribed above these portals. There is room for other temples and why should not one of these be devoted to the science and the art that I represent, to the study of the atmosphere, and the utilization of that knowledge for the benefit of man? Give meteorology a home of its own among these temples of science, and its students will build a noble intellectual structure. Provide generous fellowships, stimulate able physicists to devote their lives to this study, and thus assure the development of useful meteorolgy by future generations of men.

But is there a future for meteorology? Can we to-night lift the curtain and look forward? What are the problems that now seem to be pressing for solution? The great problems of the past were vital to the progress of science and to the welfare of mankind. Some of these problems still await our careful attention, and other newer ones have become prominent. This present generation of men must provide for this future study. We understand the general nature of the work that remains to be done, but a future generation must do it. It is our first duty to provide for the education of the young men that are to carry the work a few steps further forward. Progress in knowledge is always slow. How slowly Africa has been opened up. How hard it was to find the North Pole. How long the world waited for Christopher Columbus to cross the Atlantic.

With the kind assistance of Professor Wm. Hallock and his colleagues I have prepared a few experiments to illustrate the points to which I would draw your attention. But first I must emphasize my statement that as soon as one generation of men arrives at a simple law or generalization, then another generation calls attention to the fact that there are exceptions to these laws and that obscure influences are at work preventing the operation of any one single, simple law. Thus

a new series of researches opens up; we descend to the study of details and try to unravel all the complexities of natural phenomena. To enforce this point we may say that in our atmosphere every local weather phenomenon results from the interaction of the following seven forces:

1. The diurnal rotation of the earth on its axis.

2. The annual revolution of the earth in its orbit.

3. The attraction of gravitation holding the atmosphere to the earth.

4. The centrifugal force resulting from the rotation of the earth on its axis, and due to the inertia of the moving masses of air.

5. The molecular forces known as heat, light, chemism, electricity and radiant energy received by radiation from the sun with all the variations depending upon latitude, diurnal rotation and annual revolution.

6. The loss of heat by radiation from the earth and atmosphere.

7. The irregular expansions due to the irregular distribution of heat in the atmosphere which depends on the distribution of continents and oceans, and the presence of an easily condensable vapor like steam mixed with the permanent gases, nitrogen and oxygen that form the great mass of the atmosphere.

You will see from this brief and partial enumeration that we have to do with very complex combinations of phenomena, and that the results must vary with every slight variation in any one of these forces. Worse than this, we have not yet been able to observe or investigate the boundary between our atmosphere and the illimitable planetary space beyond. We know not whether gaseous particles are being added to and removed from this outer boundary. We know not whether our outer layer of atmosphere experiences any resistance from the cosmic ether as the earth rushes along in space. There are many speculations as to the origin of the earth's atmosphere; not only do these belong to geology, cosmic physics or cosmology, but they also lie at the foundation of meteorology. In the present state of our knowledge these are merely speculations; dynamic meteorology passes them by in silence and assumes that the atmosphere is now unchangeable as to its composition and mass. But who knows how soon the day will come when we shall have to recognize that a change has taken place! From this point of view I should say that in logical order the first problem for future study bears on the condition of the outer layer of our atmosphere, and in fact, my predecessors in this course of lectures, Professor R. S. Woodward, of Washington, and Professor J. H. Jeans, of Princeton, have already touched upon this question. More than that, Dr. C. C. Trowbridge, of Columbia University, has brought together many interesting facts relating to the trains left behind by meteors or shooting stars as they rush through the upper air. These meteors become visible at altitudes as high as 120 miles, showing that at that elevation there are obstacles of a

nature analogous to that of a resisting gas. In fact, as the meteors are burned up, we must acknowledge that the débris are perpetually making new additions to our atmosphere. So important is this question, both to astronomy and to meteorology, that the Astronomical and Astrophysical Society of America has lately started an inquiry as to what methods are available for photographing meteors and meteor trains, or what studies can give us any facts about the highest air. I understand Professor Woodward to state that there is a mechanical possibility of the existence of another atmosphere above that which affects our barometer, which therefore may revolve about the globe, like the rings of Saturn, in equilibrium within itself.

The most interesting definite problem bearing on the highest atmosphere relates to the cause and nature of the aurora borealis. These beautiful northern lights have been carefully studied by Swedes and Norwegians. Twenty years ago, all the nations of the globe united in a series of expeditions to both the arctic and antarctic regions for the study of magnetism, auroras and meteorology. Since that date four special expeditions have been sent northward by Norwegians, and the leader of these, Professor Birkeland, of Christiania, has developed some new views as to the aurora, that have been confirmed by the mathematical investigations of his colleague, Professor Stoermer. They have devised remarkable ways of continuous photography and accurate calculation of altitudes.[2] The publication of the details of their work has begun, and I think we may safely anticipate that future generations will busy themselves developing the ideas that are now being presented by these physicists. All that we need say at the present moment is that particles which we call ions (or, when they are electrified, electrons), pass with the velocity of light from the sun to the earth. If this be incredible, we must at least say that some influence passes from the sun to the earth, with the speed of gravity or the speed of light, causing electrons from space or from the celestial bodies to approach the earth's atmosphere with great speed. But no sooner do these come within the influence of the earth's magnetism (and that influence extends to great distances beyond the atmosphere), no sooner do the electrons feel this influence, than they are diverted from their straight-line courses and begin to describe curves surrounding the earth like spiral corkscrews. Whenever such particles enter certain gases (such as krypton), the gas becomes luminescent or phosphorescent, and gives us the auroral light. This hypothesis is sufficiently complex to allow of many uncertainties as to details. It is at present in its formative stage, but there is good reason to believe that we have here a solid base on which to build a structure that will carry us from the firm ground of experimental laboratory physics over into the equally firm, but unexplored region of mathematical cosmical physics.

[2] One hundred and ninety miles were recorded on March 14, 1910.

Let us come down from the highest atmosphere to some of the phenomena nearer the earth's surface. Possibly you may think that to the agriculturists the vital question is how to make it rain or how to stop the rain, according to the needs of the farmer. You may ask what are the ultimate causes of calamitous droughts, such as those of Syria, India and Australia, or the less injurious dry periods in Europe and America. These usually result from several successive years of deficient rainfall, as in the famous Biblical story of seven years of high water and seven years of low water, in the river Nile, in the days of Joseph. We have now many years of continuous record of the fluctuations of this great river and we know something of its irregularities. In order to understand why and when these droughts should occur, we must first understand how rain and snow are formed in the clouds and why rain does not always fall from the clouds. I have here on this laboratory table a small globe filled with the vapor of water mixed with air as it ordinarily occurs in the atmosphere. Now we know that when moist air rises up to the level of the clouds, it has expanded and by pushing aside the adjacent air has done work in its expansion. That work has used up some of the internal energy of the air which we call heat energy, so that the air has become cooler, just as steam expands and pushes the piston of a steam engine. When by this cooling the temperature of the moist air has been so reduced that it is near the dew-point, then the air is saturated with moisture and a cloudy condensation begins. This invisible vapor in the air begins to condense around every little particle of dust and every invisible electron. You have seen an ice pitcher covered with moisture on a warm summer day. In the same way these atmospheric dust particles are covered with moisture. I will now allow the air in this globe to expand by opening this lower stopcock leading to a low pressure chamber and you will notice the formation of a slight cloud of haze. The cloud is, however, not very dense because there is not much dust in the air. I will now repeat the experiment. First I will exhaust the air already in the globe, then close the lower stopcock. I wish to introduce into the globe more dust than is in the ordinary air of the room. To do so I light a match and hold it so that the smoke from the flame is near the upper end of the tube. When I turn the upper stopcock so that the vacuous space may become filled with air, the inrushing air carries the smoke in with it. I close the upper stopcock and now the globe is full of dusty moist air. I open the lower stopcock, this dusty air expands downward into the lower pressure chamber and you see a dense cloud of fog is formed. These successive steps illustrate the ordinary method of the formation of clouds, but not of rain. To understand that, we must go a step further. Thus far I have allowed the dusty moist air expanding downward to increase its volume in the ratio of 600 or 650 to 760, *i. e.*, 1 to 1.2 or 1.3. I will

now enlarge the lower chamber so that the expansion may be in ratio of 500 to 760 or 1 to 1.5. Moreover, I will not allow any dust to enter the upper globe, but will draw into that globe dustless air filtered through this bit of cotton wool. If now I allow moist or saturated dustless air to expand into the lower chamber from the pressure 760 to that of 500 or an expansion of about 1.5 in volume then I shall form not a cloud of small particles, but a few larger drops of water. This is the process that must be going on within the thunder-cloud, or in fact inside any rain-cloud. Out of the great mass of moist air that makes up the whole cloud only a small proportion is free from dust and of that only a small portion expands rapidly enough to form drops of rain-water.

I think you will see that the firing of cannon or dynamite in order to make a great noise is not likely to form rain and in fact can not possibly bring it down. Neither can it prevent the formation of hail or rain. If we wish to avert heavy rain or hail we must either cut off the supply of moisture, or else prevent the rapid expansion, or else throw dust upward into the air to cause cloudy condensation instead of rain. Apparently this latter process is carried out for us in nature when great forest fires afford enough particles of smoke to provide for the cloudy condensation of the free moisture. From the great clouds of smoke that attend these forest fires we get no rain until after a long time the heat that is in the cloud is lost by radiation, or until larger drops are formed by further expansion.

Even the bombardment of a cloud by the explosion of dynamite within it is inefficient to produce rain, in part because no violent concussion can drive the cloud-particles together into large drops of rain, and in part because the explosive itself furnishes more dust particles and more nuclei of condensation and therefore produces clouds instead of rain. In the same way the bombardment of the clouds by means of vortex rings is inefficient.

I have here an apparatus for making vortex rings of air; you notice that a slight stroke on the rear side of this box drives forward a vortex ring of smoky air. It is a beautiful sight and very instructive in many ways, but the special form of cannon devised in Italy to send such rings of gunpowder smoke up into the clouds and break up the formation of hail does not usually send them higher than 1,000 feet; they break up long before they reach the clouds. We have no evidence that they ever reach them, or that they could have any effect if they did so. If they carry up much dust they ought to have a slight effect in producing cloudy condensation, and thus cutting off the formation of rain or hail. But this effect is certainly too slight to be appreciable in our statistics. I regret to think of so many thousands of farmers wasting time and money on this delusion. You know that De Morgan after spending much time in combating analogous delusions wrote an inter-

esting volume classifying as "paradoxers" all those who believed in squaring the circle, or in perpetual motion, or that the world is flat, or that the sun do move. They can believe the impossible. It is the same way with those who expect great mechanical work to be done without the expenditure of a corresponding amount of force or energy. The law of the conservation of energy runs all through meteorology as it does through the mechanics of nature everywhere. Energy and work may be transformed to and fro, but never destroyed nor created by man.

I have no doubt that we shall some day long years hence acquire some control of the atmosphere, but at the present time we are not ready for it, neither scientifically nor socially. I say socially because if *A* could make it rain when his neighbor *B* wants dry pleasant weather, we should have grumbles and lawsuits and socialistic eruptions far worse than now.

I dare say that if ever we are to follow in the footsteps of Franklin who deprived lightning of its terror, or of Redfield who taught the mariner how to avoid the dangers of the storm-center, we must adhere closely to nature: when once we know the details of her methods, then we may hope to learn how to make or to prevent the weather. To this particular study of the formation of rain, John Aitken, of Scotland, Carl Barus, of Brown University, and C. T. R. Wilson, of Cambridge, England, have especially contributed by their laboratory experiments. It is a question on which meteorological observers and laboratory physicists must labor together.

In India the prediction of great droughts has long been held to be one of the most important questions that can be attacked by the weather bureau of that country, and eminent men have worked upon it for twenty years past. The progress of their studies has gradually led us to see that the moist air of the southwest monsoon from which the rain falls has come from an unexpectedly great distance, namely, from the southern Indian Ocean. As you see on this globe before you, during the Asiatic winter season we have northeast trade winds here, and southeast trade winds there, south of the equator; but in the Asiatic summer season the heated air of the great continent of Europe, Asia and Africa, produces such an immense disturbance that over a large portion of the Indian Ocean the southeast trade wind disappears, or rather is turned about and flows northward over the equator to the region of the northeast trade, which is also turned about, and both combine to feed the great southwest monsoon of Asia. Knowing the origin of this moist monsoon, we shall be able to determine the probability of droughts or rains in India when we know whether the supply of air is sufficient and whether it will flow over the right region, or whether it will be deflected away from India. But to settle this question is at present very difficult.

The flow of any current of air is determined largely by the pressure

of other air on each side of it, and it is quite possible that the flow of the southwest monsoon, at any place and time, may be affected by something that occurred long before in a very distant part of the globe. At first it was thought that the condition of the snow lying on the ground in the Himalaya Mountains would determine the movement of the monsoon and the amount of rain in the lowlands, but, as I have elsewhere stated, the supply of air to the southern Indian Ocean must ultimately come from the great westerly winds of the roaring forties, and therefore the Asiatic circulation must be affected by the condition of affairs in south Africa and the south Pacific and even the south Atlantic oceans.

On November 14, 1896, simultaneous balloon ascensions were made from St. Petersburg and Munich and from intermediate cities, in the midst of an area of high pressure that was moving slowly eastward over Europe.[3] My study of these observations in the light of my maps of high-level isobars for the northern hemisphere[4] gave occasion for the following long range forecast which was made early in December,[5] and, of course, long before we received any reports from India. "As a result it is quite possible that this area may have brought to upper India light snow followed by cold dry weather about the first of December, 1896."

As this prediction was abundantly verified, as shown by the reports which we received a year later, it may be worth saying that the study of these upper isobars explains why the areas of high pressure over North America usually move at first from the northwest; subsequently their velocity diminishes while the path turns more nearly eastward; on the other hand, similar areas of high pressure and cold air in Europe are apt to come from the northeast before they turn southeastward.

It seems certain that the atmosphere is so mobile that whatever happens on one side of the globe will soon be known by its results on the opposite side. Whatever happens in the atmosphere fifteen miles above the earth will soon produce results at the earth's surface far away. Meteorology must embrace the whole atmosphere above and below, north and south, east and west.

I suppose that the most important problem of the present time is to attain a clear idea of the mechanics of the earth's atmosphere as a whole. We separate this problem into three closely related divisions. First we treat the atmosphere as we would a liquid of very rare but uniform density. Next we introduce the idea of a gas which enlarges or contracts in volume with every change of pressure or temperature.

Finally we pass from simple dry air and moisture to study the

[3] See *Monthly Weather Review*, November, 1896, p. 415.

[4] Published as chart VII. in that number of the *Review*.

[5] See p. 420 of that same number of the *Review*.

changes of volume and pressure and corresponding changes of temperature, moisture and cloud. These studies are comprised under the technical terms hydro-mechanics, aero-dynamics and thermo-dynamics. The atmospheric problems of to-day and of all future time will undoubtedly be concerned principally with these three classes of questions, and another century may elapse before men can solve them all.

I have here at hand a circular table which represents a small portion of our globe within the polar circle, while the center of the table represents the north pole itself. I will set the table in rotation; of course it revolves much more rapidly than the earth does. It is now revolving from left to right as the earth itself does when we stand facing the north and see the sun rising in the east. If I shoot this ball so that it rolls straight across the revolving table, it will not trace a straight line on that table but a curved line. If the track lie on the right-hand side of the pole the curvature will be toward the equator, but if on the left-hand side then the curve will be away from the equator. In both cases the curvature is toward the right hand as the ball progresses. This sentence corresponds to the two cases of a body moving, respectively, eastward or westward on the earth. When it moves eastward it has a greater centrifugal force than the corresponding point on the globe and pushes toward the equator. When it moves westward it has a less centrifugal force and retreats toward the pole. Corresponding phenomena occur when a pendulum is swung to and fro as in the Foucault pendulum experiment; or when a gyroscope is rapidly spun, as was also done by Foucault. We were long since taught by Poisson, Tracy and Ferrel that any mass, whether solid, liquid or gaseous, moving on the surface of the rotating earth in the northern hemisphere experiences a deflection to the right, and this is true under ordinary circumstances. Perhaps you will not be surprised to learn that our distinguished mathematical colleague, Professor Chessin, of Washington University, St. Louis, has lately reopened this question and even yesterday in this very lecture room showed that under some circumstances the deflection may be to the left, so that questions which have been considered settled for many years are now deemed worthy of a new investigation. Thus in meteorology we must expect to be frequently called upon to revise our old ideas in the light of the newest researches.

The study of hurricanes and typhoons long ago led to the general conclusion that they consist of comparatively thin layers of air revolving horizontally in nearly circular orbits, and therefore analogous to the revolving horizontal wheel of a gyroscope whose axis is vertical. On the other hand the phenomena of the waterspout at sea and the tornado on land had led to the idea that in these cases we have to do with nearly vertical ascending currents of air. Redfield's careful construction of numerous weather maps made him certain that in a hurricane the winds

trend inward toward the center to such an extent that the hurricane can not be considered as a system of circular rotations, but of spiral inflowing ascending and overflowing currents of air, or the ideal cyclonic vortex movement. The same conclusion was soon formed with regard to the waterspout and tornado, the only differences being as to the question what are the angles of inflow, ascent and overflow? Since 1871 a still more careful analysis of the United States daily weather maps has shown that it is necessary to consider the fact that the winds on the west side are colder and drier than those on the east side of the storm center. Thus it follows that in the northern hemisphere we have cold dry northwest winds swirling around the central low pressure and running under the more moist southerly winds, sometimes even going so fast as to overflow these for short distances while pushing them aside. In this respect a hurricane storm lies intermediate as to its mechanism between the thunder-storm and the waterspout. In the waterspout we have a relatively small mass of air, no great differences of temperature, a rapid ascension with a rapid horizontal rotation. In the thunder-storm we have a simple horizontal overturning; cooler or drier air descends from overhead and warmer or moister air ascends from below. In every style of storm and in every form of atmospheric circulation there is and must be overturning with overflow and underflow.

The problems of simple overturning have been studied by Margules from the thermo-dynamic point of view. Perhaps I can illustrate these problems by means of this glass box with vertical divisions. I will place this dividing blanket in the middle. On the left-hand side we have a mass of air cooled by this adjacent ice; on the other side is an equal volume of air at the temperature of the room. If I quickly remove the blanket the cold air settles down, flowing beneath the warm moist air and covering the bottom, while the warm air is raised to the top. The differences of density have caused an interchange of energy due to the action of the force of gravity quite independent of radiation or conduction of heat. The descending cold air has expended some of the potential energy of its position in elevating the warm air. If the warm air was anywhere near the point of saturation, then its small loss of temperature due to its rising and expanding may have produced a haze in our little experiment, but in nature it often produces a great thunder cloud, and every gradation of cloud from that form down to the thinnest stratum.

These overturnings are perpetually going on in every room of our buildings and of course in the atmosphere. If a cloudy mass descends it is warmed by compression as it descends; evaporates all its cloudy particles, and in its further descent eventually has its own temperature raised. In general we have very low temperatures at great altitudes in the atmosphere, but if such air were brought down rapidly to the

earth's surface it would be warmed up by compression so as to be insufferably hot and dry. This is the method of the formation of the hot, dry southwest winds of Kansas, Arkansas and Oklahoma where "corn is roasted on the stalk." Our North American cold winds from the northwest represent one step in the general condition of the whole atmosphere; they are undoubtedly descending winds, but descending so slowly and rolling along the earth to such great distances toward the equator that the air has time to cool by radiation before it reaches us. This is the formation of our areas of "high pressure" and cool, dry, clear weather.

In close analogy to the steam engine driven by heat that is derived from fire but is lost in the condenser, so the motive power in the atmosphere is the heat received from the sun, but lost by radiation from the earth. As to quantity and quality of this solar heat we are still at the beginning of our knowledge. Eminent authorities adopt figures ranging between two and four calories per minute per square centimeter. Every effort must be put forth to determine more accurately this fundamental datum.

Very many insist on searching our climatological records for periodic phenomena such as solar rotation periods and sunspot periods and lunar periods. Brückner's period of 35 years is quite famous. We have as yet very little data on which to base satisfactory researches into these questions, but the trend of our present knowledge is to show that in so far as these periods depend upon external or cosmical influences they are too feeble to be of importance; in fact, too feeble to be clearly recognized.

On the other hand, in so far as they depend on the internal mechanism of the atmosphere, they die out in a short time after they have been started, and are not permanent or steady periods in the proper sense of the word, but are driven and imposed on the atmosphere by conditions outside of it. Just as we see ripples standing in the rear of a stone in a shallow stream of water, so we have waves and clouds in the atmosphere on the leeward side of every obstacle. The annual periodic changes in the declination of the sun and in the resulting monsoons are undoubtedly accompanied by great reactions in our atmosphere extending like waves around the whole globe; but these again die out in a few years. Almost the only periodic phenomenon due to the internal mechanism of the atmosphere, one that is permanent and appreciable, is the semi-diurnal change of pressure which appears likely to be an internal phenomenon of resonance maintained by the regular diurnal change of temperature. But these questions are not settled and remain for further investigation.

I think the great climatic changes that seem to have taken place during geological history must be explained in connection with the

corresponding changes that have taken place in the orography of the continents, and the changes in the distribution of land and water. The great gorges that extend from the Hudson through New York Bay toward the Middle Atlantic and from the Congo on the western coast of Africa also into the mid-Atlantic prove beyond controversy that there was a time when the ocean level was 5,000 feet lower than now, relative to the land on either side. Of course we know that mountain ranges have risen gradually by successive slight earthquake rifts; that the surface of the globe has always been cracking and bending, rising here and falling there. When we are able to demonstrate clearly the connection between our present climates and our present surface orography, then we shall be able to show what geological climate must have prevailed in any other age if the geologists can tell us what were then the characteristics of the surface. I consider this to be the ultimate end of meteorology, namely, the logical deduction of the climate and the weather for any time and any given configuration of continents and oceans. When we have attained this goal; when meteorology has become more truly deductive, then we can pass to the satisfactory discussion of the great problems that we now can merely toy with like children. Then we shall know whether Mars is inhabitable, and whether man could possibly have existed and evolved anywhere on this earth during geological ages preceding the present.

I am safe in saying that it is impossible to foresee in detail the problems of the future meteorology. I have by a few special cases illustrated the general conclusion that a long array of unsettled problems confronts those who would understand the operations of our earth's atmosphere. The fundamental problem of to-day is to educate men for the work that we see is at hand. Friends of science and humanity must be found who will provide for the expenses of men able to work on these problems. We need laboratories, physicists and sympathetic supporters. Perhaps the very first step is to provide generous fellowships, securing a support for enthusiastic men who are adapted to these researches. Atmospheric phenomena are not too difficult for us, nor is there any known natural limit to our steady intellectual progress. Those who are attentive to the voice of nature hear a command like that given to Joshua, "Go up into the land and possess it." But we also hear the voice that said unto Adam, "In the sweat of thy brow shall the earth bring forth its fruit." Whatever is worth doing involves hard work both physical and intellectual. We have many years of work before us, many abstruse and difficult problems, but what we ask first and last is your kindly sympathy and hearty support until success crowns the end.

KANT AND EVOLUTION

By Professor ARTHUR O. LOVEJOY

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II

IN the previous part of this article we have examined two of Kant's early writings, and have found in the one a confused mechanistic theory of cosmic evolution, and in the other a sort of anthropological and social evolutionism—neither doctrine being truly original with Kant himself. But we have discovered no traces of biological evolutionism, in the sense either of an admission of the possibility of the production of the organic out of the inorganic by natural processes, or in the sense of an assertion of the mutability of species. In the writings next to be considered we shall find Kant brought directly into the presence of the more fundamental questions of theoretical biology.

3. *The Two Essays on the Conception of "Race," 1775, 1785.*—The review of Moscati (1771), summarized in the preceding instalment of this survey, was the earliest indication among Kant's writings of a growing interest in a group of scientific problems which always thereafter much occupied his attention: namely, the genetic problems of physical anthropology. The beginnings of that science, in its systematic form, are usually credited to the treatise of Blumenbach, "De generis humani variatione nativa," 1775. Blumenbach, says the historian[21] of eighteenth century anthropology, "derived his zoological facts chiefly from Buffon. His philosophy, and in particular his fundamental conception of man's place in nature, were founded on the system of Leibniz. The opening sections of his book at once show his principal preoccupations in the inquiry—*viz.*, to establish the limits, on the one hand, between man and the animals, and, on the other hand, between the different races of men. These two remained the chief themes of anthropology throughout the succeeding period." It was to the second of these themes that Kant especially addressed himself. His first discussion of it appeared in the same year as Blumenbach's treatise. In the "preliminary announcement" to his "Lectures on Physical Geography," delivered in the summer semester of 1775, Kant took for his topic "The Different Races of Men";[22] he reverted to the subject in an article in the *Berliner Monatsschrift* for November, 1785, entitled

[21] Günther, "Die Wissenschaft vom Menschen im 18ten Jahrhundert," p. 287.

[22] "Von den verschiedenen Racen der Menschen." This writing will here be referred to as the "Physical Geography." It is to be found in Hartenstein's edition, 1867, II., 433.

"Elucidation of the Conception of a Race of Men."[23] These two essays do not significantly differ in doctrine, and they may most conveniently be dealt with here as slightly variant expressions of the same arguments and conclusions. They are among the most important documents for the determination of Kant's position with respect to the theory of evolution.

Kant derived not only most of his zoological facts, but also some of his ideas of scientific method, from Buffon. The latter, like Maupertuis, had ridiculed the "systems" and "methods" of the great systematists, Linnæus and Tournefort, and had looked with a good deal of contempt upon their absorption in purely descriptive and classificatory science. Schemes of classification were convenient, no doubt, and accurate description essential; but there was a higher stage of scientific inquiry to which these were merely vestibulary. Buffon wrote:[24]

> We ought to try to rise to something greater and still more worthy of occupying us—that is to say, to *combine* observations, to generalize the facts, to link them together by the force of analogy, and to endeavor to arrive at that high degree of knowledge in which one can recognize particular effects as dependent upon more general effects, can compare nature with herself in her larger processes.

This spirit Kant had in some degree caught; and in the "Physical Geography" he proposes a modification in the nomenclature of the sciences which should express the distinction between two types of scientific inquiry. He observes:

> We are accustomed to use the words "*Natursbeschreibung*" (description of nature) and "*Naturgeschichte*"[25] (natural history) as synonymous. But it is manifest that the knowledge of the things of nature as they now are still leaves to be desired a knowledge of what they previously have been, and of the changes through which they have passed in order to arrive at their present condition. A "history of nature"—such as is still almost completely lacking—would make known to us the alterations of the form of the earth and those which the terrestrial creatures (plants and animals) have undergone in the course of their natural migrations, and their consequent divergences from the primitive type of their ancestral species (*Stammgattung*). Such a science would probably reduce a great number of seemingly distinct species (*Arten*) to mere races of a single genus (*Gattung*), and would transform the now current artificial system (*Schulsystem*) of nature-description into a physical system for the understanding.

In this, manifestly, Kant shows a lively sense of the nature and importance of genetic problems in the investigations of the naturalist. It is true that he somewhat naïvely makes the distinction between the

[23] "Bestimmung des Begriffs einer Menschenrace," here referred to as the "Conception of Race." V. Hartenstein edition, IV., 215.

[24] "Discours de la manière d'étudier et de traiter l'histoire naturelle." In "Œuvres," Lanessan ed., Vol. I., p. 6.

[25] Later (in the "Use of Teleological Principles") Kant proposed to express this distinction by the words "physiography" and "physiogony."

genetic and the descriptive equivalent merely to the distinction between past and present. It need hardly be said that genetic inquiries in science are not necessarily purely historical or archeological inquiries, since phenomena of genesis may be recurrent phenomena, taking place in accordance with the same laws in past or present. But, though he blurred the idea somewhat, it remains true that, in his contrast between two types of scientific research, Kant exhibited his inclination to what, in the vaguer sense, may properly be described as an evolutionary habit of mind. It still remains, however, to determine just how far this carried him, when he came to the consideration of definite problems.

His problem of predilection, as I have said, was that of the nature of a "race," the relations of different races, and the causes of their diversity in physical characters. And this made necessary, at the very outset, a consideration of the nature of a "species." Here, once more, Kant follows Buffon: "Animals, however different they may be in form, belong to the same physical species if, when mated with one another, they produce fertile offspring."

This Buffonian rule gives a definition of natural species as such (*die Definition einer Naturgattung der Tiere überhaupt*), in contrast with all artificial species (*Schulgattungen*). The artificial classification deals with *classes*, which are grouped together upon the basis of similarity, the natural classification deals with lines of descent, grouping animals according to blood-kinship. The one provides an artificial scheme to aid the memory, the other a natural system for the understanding. The purpose of the former is merely to bring animals under labels, that of the latter is to bring them under laws.

These references to *Naturgattungen*, determined by the criterion of fertility of offspring, are themselves hardly in the language of transformism. Yet one who employed such language might still regard these "true species" as eventual results of divergent descent from common ancestors. But when we examine Kant's way of further defining these species, we find that his notion of them expressly precludes the possibility of any transformation of one into another through descent. By the Buffonian test, he says:

All human beings belong to one and the same natural species, since in mating they always beget fertile offspring, however dissimilar the parents may be in appearance. For this unity of natural species there can be but one natural cause, *viz.*, that all men belong to a single stock (*Stamm*), from which they have originated or at least could have originated. In the former case [*i. e.*, of actual descent from common ancestors], they belong not only to one and the same species, but also to one family; in the latter case they would be similar to one another but not related, and it would be necessary to assume a number of separate local creations: an opinion which multiplies causes beyond necessity.[26]

[26] The same ideas are perhaps still more clearly expressed in the article "On the Use of Teleological Principles in Philosophy," 1788: "There could be no more certain test of diversity of stock (*des ursprünglichen Stammes*) than the inability of two different hereditary branches of mankind to engender fertile

This argument, by which Kant reasons that all men are of one *Stamm,* directly implies that men and other animals are *not* of one *Stamm, i. e.,* are not related through any lines of natural descent. For he makes identity of species synonymous with community of descent, and diversity of species synonymous with separateness of descent. In other words, his manner of distinguishing a species from a race rests upon wholly anti-evolutionary presuppositions.

Within the limits of a species, however, Kant holds that very considerable modifications of physical character may be brought about in the course of successive generations. Now (apart from individual variations not transmitted to offspring), there seem to Kant to be two significantly different types of heritable peculiarities: those which are *invariably* inherited, and those which are only *alternatively* inherited. Thus the colors of a negro and a white who marry are both manifested in the offspring; children of such marriages are always mulattoes. But the complexions of the children of a dark man and a blonde woman are not necessarily a compromise between the complexions of their parents. Some or all of the children may resemble one parent only, and show (with respect to any given character) no marks of their descent from the other. By means of this distinction Kant differentiates a "race" from a "variety." Those members of a single species which also possess in common characters of the invariably hereditary sort belong to the same race; those which possess in common (and, so long as they mate with their own like, transmit to their offspring) characters that, upon cross-breeding with other types, are only alternatively hereditary, constitute only "varieties."

These definitions of "species" and "race," it is true, involve—as Kant recognizes—some revision of the classifications of the systematists.

> Originally, when only similarity and dissimilarity were taken into consideration, it was customary to group classes of creatures under *genera* (*Gattungen*). But if it is their descent we are considering, it is necessary to ask whether these classes are species (*Arten*) or only races. The wolf, the fox, the jackal, the hyena and the domesticated dog, are so many classes of quadrupeds. If one assumes that each of them has a special descent (*Abstammung*), they constitute so many species; if one grants that they may have sprung from a single stock, they are simply races of that stock. In "natural history" (*Naturgeschichte*), which has to do only with generation and descent, the words *Art* and *Gattung* mean the same;[π] only in "nature-description," where it is merely a question of the comparison of characters, does a distinction between offspring. But where the generation of such offspring is possible, the utmost diversity of external appearance is no obstacle to regarding the parents as having a common descent. For if they can, in spite of this diversity, produce offspring that exhibit the characters of both parents, then they may be classified as belonging to two *races* of a single stock, which originally had latent within itself the characters that were to be developed in each separately."
>
> [π] It is for this reason that, in translating Kant's expositions of his own doctrines, I have, so far as possible, rendered both *Art* and *Gattung* by "species." The citation is from the "Conception of Race," § 6, *n.*

them find place. What in the latter is called a species must in the former often be designated as a race.

Kant's elaboration of an ethnological scheme upon the basis of these definitions does not here concern us. But it is worth noting that he finds that the only character which is "invariably inherited" from both parents—and therefore the only mark of a true or "natural" race—is skin-color; and that, using this criterion, he finds that there are just four races of men, the white, the negro, the Mongolian or "hunnish" and the Hindu. From these four originals Kant was prepared to explain all the hereditary shadings of the various peoples of the earth as the results of diverse hybridizations. The question of greatest interest of all, from the standpoint of biological theory, still remained to be asked. Within the limits of a "natural species," we have seen, Kant recognized that profound modifications of physical characters took place, and became permanent and transmissible through heredity. Thus, he thinks it at least a probable conjecture that the original type of man was white. But from white ancestors black and yellow and brown races have been developed. How did this come about? What, in Kant's words, are "the immediate causes of the origination of these different races"? He has his own entirely confident answer to the question. A natural answer for an eighteenth-century biologist would have been to say that these differentiated racial characters are the results of environmental modifications of individuals, which gradually have become hereditary. But such an explanation Kant emphatically rejects. It would hardly do to call him an eighteenth-century Weismannist; but he was (though not without serious but unrecognized inconsistencies) a vigorous opponent of the supposition that acquired characters can be inherited, and an unqualified partisan of the doctrine of the continuity and unmodifiability of the germ-plasm. His reasons for taking this position betray once more his entire inability to conceive of the transformation of "real" species into other species.

There are current, he admits,[28] many, though poorly authenticated, stories of cases in which acquired characters have been inherited: tales of the "influence of the imagination of pregnant women" upon the fœtus; of "the plucking out of the beard of entire peoples, and of the docking of the tails of English horses, by which nature was compelled to eliminate from the processes of reproduction in these organisms a product for which those processes were originally organized"; accounts of "the artificial flattening of the noses of new-born infants, which peculiarity nature is supposed finally to have taken up into the reproductive faculty." Kant rightly regards all such stories with a sceptical eye; but his theoretical reasons for doing so are significant. These accounts are to be rejected because they conflict with a general

[28] "Conception of Race," § 5, and *Anmerkung*.

principle or presumption of science which must be adhered to at any cost, namely:

that throughout organic nature, amid all changes of individual creatures, the species maintain themselves unaltered (*die Species derselben sich unverändert erhalten*)—according to the formula of the schools, *quaelibet natura est conservatrix sui*. Now it is clear that if some magical power of the imagination, or the artifice of men, were capable of modifying in the bodies of animals the reproductive faculty itself, of transforming Nature's original model or of making additions to it, which changes should then become permanent in subsequent generations, we should no longer know from what original Nature had begun, nor how far the alteration of that original may proceed, nor—since man's imagination knows no bounds—into what grotesqueries of form species might eventually be transmogrified (*in welche Fratzengestalt die Gattungen und Arten zuletzt noch verwildern dürften*). In view of this consideration, I for my part adopt it as a fundamental principle to recognize no power in the imagination to meddle with the reproductive work of Nature, and no possibility that men, through external, artificial modifications, should effect changes in the ancient original of a species in any such way as to implant those changes in the reproductive process and make them hereditary. For if I admit a single instance of this sort, it is as if I admitted the truth of a single ghost-story or tale of magic. The boundaries of reason are then once for all broken through, and errors rush in by thousands through that opening. There is, meanwhile, no danger that, in adopting this conclusion, I may take a position of blind or stubborn incredulity towards real facts of experience. For all these romantic (*abenteuerlich*) occurrences have without exception one peculiarity, namely, that they can not be subjected to experiment, but are supposed to be proved merely by casual observations. But whatever, though capable, indeed, of experimental testing, offers no experimental evidence, or employs all sorts of excuses to avoid such a test, is mere fiction and illusion.[29]

Nothing could better exhibit Kant's characteristic state of mind on biological questions than this passage. There are occasional bits of sound sense in it and of discriminating judgment about scientific method; and there is a certain power of at least seeing where the significant problems lie. Yet, though he had come under the influence of evolutionistic conceptions, and is in these very writings endeavoring to apply genetic methods to certain biological inquiries, he recoils in horror before the idea of admitting that real species are capable of

[29] The "Physical Geography" is equally emphatic in repudiating both inheritance of acquired characters and mutation of species: "External things may, indeed, provide the occasions, but they can not be the efficient causes, of the appearance of characters that are necessarily transmitted and inherited. As little as chance or physico-mechanical causes can bring an organic body into existence, just so little can they imprint anything upon the reproductive faculty, that is, produce any effect that is itself reproduced, either as a special form or as a relation of the parts. Air, light and nutrition can modify the growth of an animal body, but they can not furnish this change with a power of reproducing itself after its original causes are no longer operative. . . . For it is not possible that anything should so penetrate into the reproductive faculty as to be capable of gradually removing the creature from its original determination and bringing about a real and self-perpetuating departure from the specific type (*Ausartung*).

transformation. It is primarily in the name of a pseudo-axiom of scholasticism that he pronounces for the fixity of species! But in reality, as his expressions show, it was because of certain temperamental peculiarities of his mind—a mind with a deep scholastic strain of its own, one that could not quite endure the notion of a nature all fluent and promiscuous and confused, in which series of organisms are to an indefinite degree capable of losing one set of characters and assuming another set. He craved, after all, a universe sharply categorized and classified and tied up in orderly parcels. And thus, though he had learned from the newer scientific tendencies of his time that the business of science is with processes, and especially with genetic processes, this scholastic side of his mind prevented him from making any thorough application of the principle to biology. He was prepared to go a considerable distance upon the path of evolutionism—but to admit that organisms (always to Kant, because of their "teleological" character, forming in nature a realm apart) were so far plastic that the very archetypal traits of species could, under the play of ordinary, environmental agencies, be altered past recognition—that was too much!

Meanwhile, it must be remembered that he was already committed to the admission of a large measure of modification within the species. But if it were so incredible a thing that the "original form" of a species should be radically altered, why was it not equally incredible that black men should be descendants of white men? Why did not the arguments against the transformation of one species into another species apply equally to the transformation of one race into another race? Why should one who supposed—as Kant supposed—that the wolf or hyena may have developed into the extraordinarily diversified breeds of our domestic dogs, have found it an intolerable paradox to suppose that the horse may have developed into the donkey, or both from a common ancestor? To such questions as these Kant's theory concerning the causes of the origination of races was called upon to provide an answer. The answer has an appearance of great simplicity: Kant merely said that in reality races had no characters which were not present, *but latent,* in their species from the start. In other words, he escapes the difficulties of his position by the easy artifice of a hypothesis of preformations. Nothing has been added to or taken from the germ-plasm of the species "man" since the beginning; the reproductive faculty merely contained in itself always certain alternative potencies—especially with respect to the production of skin-color—one or another of which was called into play in accordance with variations of external circumstances.

Any character that was to be transmissible (*was sich fortpflanzen soll*) must have already lain beforehand in the reproductive faculty, predetermined to develop at the proper occasion, in conformity with the circumstances amid which the animal might find itself and in which it would be obliged to maintain itself. . . . This precaution of Nature to equip all her creatures for all

kinds of future conditions by means of hidden inner predispositions, by the help of which they may maintain themselves and be adapted to diversities of climate or soil, is truly marvelous. It gives rise, in the course of the migration and change of environment of animals and plants, to what seem to be new species; but these are nothing more than races of the same species, the germs and natural predispositions for which (*deren Keime und natürliche Anlagen*) have developed themselves in different ways as occasion arose in the course of long ages.[30]

Kant's conception of the "grounds" for the existence of these *Anlagen* is manifestly teleological in the most *naïve* way; the species was fitted out beforehand with distinct elements in its germ-plasm in order to furnish its later representatives against specific contingencies that had not yet arisen, and in some cases never would arise. This idea Kant elaborates in detail in the case of the skin-color of the negro; the passage is so delightful a combination of teleological "explanation" and phlogistic chemistry[31] that it deserves to be quoted:

The presence of purposiveness in an organism is the general ground from which we infer an original preparation in the nature of a living being, having this [purpose] in view, and—if the purpose is only later fulfilled—infer the existence of duly furnished germs. Now, this purposiveness can be in no race so clearly shown as in the negro. . . . It is already known that human blood turns black simply through becoming overcharged with phlogiston (as may be seen from the under side of a cake of blood). Now the strong odor of the negro, which can not be removed by any degree of cleanliness, already leads us to surmise that his skin eliminates a great deal of phlogiston from the blood, and that Nature must have so organized his skin that it is capable, in much greater degree than is ours, of dephlogisticating the blood—this being, with us, accomplished chiefly by the lungs. But the true negroes live in lands where the air, because of the thickness of the trees and the marshiness of the surroundings, is so heavily phlogisticated that, according to Lind's account, English sailors run the risk of death from this cause when they ascend the river Gambia even for a single day, for the purpose of procuring meat. It was, therefore, a very wise arrangement of Nature so to organize the skin of the negroes that their blood, even if the lungs do not sufficiently eliminate phlogiston, is yet far more thoroughly dephlogisticated than ours. Their blood must therefore deposit a great deal of phlogiston in the ends of the arteries, so that at this place—that is to say, just under the skin—it shows through as black, though in the interior of the body it is red enough.

Such, then, are reasons why our African brother is black and has a distinctive odor.

Kant's principles of the fixity of the specific type and the essential unmodifiability of the "reproductive faculty" imply that the diverse heritable and adaptive characters of what he calls "varieties," no less than those of races, preexist in the species ready-made from the outset, in the form of special "germs" or *Anlagen*. In writing the "Physical Geography" and the "Conception of Race" Kant does not seem to have

[30] Cited from the "Physical Geography."

[31] Kant was, of course, by no means abreast of the best chemistry of his time. The passage cited was published two years after Lavoisier's direct and decisive refutation of the phlogiston theory.

clearly perceived this implication; but in his essay "On the Use of Teleological Principles in Philosophy," 1788, he expressly draws the inference.

> As for what are called varieties in the human species, I remark only that in respect to these, as well as to the racial characters, nature must be conceived, not as producing forms with entire freedom, but as merely *developing* forms in a way predetermined by original predispositions (*Anlagen*). For varieties (as well as races) show purposiveness and adaptation, and therefore can not be the work of chance. . . . The varieties among men of the same race were in all probability no less purposively implanted in the original stock (*Stamm*), in order to make possible the utmost diversity for the sake of endlessly various ends, than were the differences of race, in order to assure adaptation to fewer but more important ends. . . . There is, however, this difference, that the racial *Anlagen*, once they had developed—which must have already happened in the earliest period—no longer produced any new forms, nor yet permitted the old ones to become extinguished; while the *Anlagen* of varieties—at least so far as our knowledge goes—seem to indicate a nature inexhaustibly productive of new characters, both inner and outer.

It is a conventional practise, especially among German writers on philosophy, to speak in a tone of reverent admiration of Kant's profound insight into the spirit and methods of empirical science. The reader, therefore, will do well to note the precise logical character of Kant's procedure in framing and supporting these hypotheses, which constitute his special contribution to biology. In the first place, he assumes, with no evidence at all, that two species incapable of producing fertile offspring when mated, thereby testify that they can have had no common ancestors. He thus, with a single dogmatic phrase, "there can be only one cause of this" infertility, begs the entire question of the transformation of species, which had been already raised in his time by writers of the first eminence, whose work was well known to him. Further, in order to reconcile his doctrine of the impossibility of any real modification of nature's "original model" for each species with his doctrine of the descent of widely divergent races and varieties from a single species, he invented the hypothesis of the latent preexistence of "germs" anticipatory of the subsequent changes of *milieu* which the species was to undergo, and destined to take command of the reproductive process when the proper occasions arrive, while the other germs obligingly retire into inactivity.[32] This, which remained to the end of his days one of Kant's most cherished notions, had most of the faults of which a scientific hypothesis is capable; and it had not even the ambiguous merit of serving the purpose for which it was designed. It was intended as a support to the anti-evolutionistic dogma which Kant had made his own: "every natural kind remains true to its original nature"; yet it was admittedly consistent with an

[32] Cf. "On the Use of Teleological Principles": "Wherever the ancestors of a race accidentally came and persisted, there was developed the germ latent in their organization with special reference to that neighborhood (*Erdgegend*) and capable of adapting them to that climate."

immense and indefinable degree of divergence, on the part of the descendants of a given pair, from the characters of their ancestors. As Kant himself observed, it assigned many of the species of the systematists to a common descent. But if the "reproductive faculty" of the primeval wolf was—as Kant grants that it may have been—capacious enough to contain special "germs" for the subsequent production, not only of wolves, but also of jackals, pug-dogs, greyhounds, dachshunds, hyenas and bull-dogs, there appeared to be no adequate reason for assigning any particular limit to the original capacity, and the consequent eventual versatility, of that faculty in any organism whatever. It was entirely open to Kant, without abandoning his theory of anticipatory germs, to regard the wolf in turn as the development of a germ implanted in still earlier ancestors, which the wolf and his diverse present progeny share in common with a group of organisms still more various; and so on *ad indefinitum*. Since the immutability of "nature's original model" was to be sufficiently salved by the simple device of supposing that model to have virtually contained within itself, and in course of time, under changing external conditions, to have extruded from itself, a vast assortment of other extremely dissimilar models, there was nothing in the most thorough-going theory of the transformation of species which could be inconsistent with an immutability of so elusive and so elastic a character. Kant's rejection of evolutionism was thus not justified even by those singular embryological speculations into which his desire to reject that theory seduced him.

4. *The Review of Herder's "Ideen."*—In 1785 Kant published a review of Herder's "Ideen zu einer Philosophie der Geschichte der Menschheit." Herder, as I have elsewhere shown,[33] was not a believer in the transformation of species; but he may perhaps be without exaggeration described as a near-evolutionist. He set forth in the "Ideen" the theory of a gradual production of organisms in an ascending series in which little by little the form and powers of man were approximated. Through all this "graded scale of beings" was conspicuous that "unity of type" which the work of Daubenton and Buffon in comparative anatomy had brought to light. The successive emergence of ever higher forms Herder ascribed to some innate potency in "nature" tending to progress and to the constant increase and diversification of life. Just how he conceived this to operate in the actual formation of organisms it seems impossible to make out; one is obliged to doubt whether he ever framed any definite ideas on the subject. But on the unity, yet inexhaustible diversity, of nature's productive power, and on the strange way in which, as he supposed, all animals and plants, and perhaps even snow-flakes and other inorganic things, are fashioned after a single archetype of form, Herder had much to say that was eloquent and impressive, if not very clear. In

[33] POPULAR SCIENCE MONTHLY, August, 1904, p. 327.

reviewing the book, therefore, Kant was naturally led to touch upon the subject of organic evolution. The passage runs as follows:

> As for the graded scale (*Stufenleiter*) of organisms, one can not so severely reproach the author because it will not consent to extend far enough to match those conceptions of his which reach far beyond the limits of this world. For the use of it even in relation to the kingdom of nature here on earth likewise leads to nothing. The slightness of the degrees of difference between species is, since the number of species is so great, a necessary consequence of their number. But a *relationship* between them—such that one species should originate from another and all from one original species, or that all should spring from the teeming womb of a universal Mother—this would lead to ideas so monstrous that the reason shrinks from before them with a shudder. Such ideas can not with justice be imputed to our author.

It is surely one of the humorous incidents in the history of science that more than one grave historian should have found, in the writings of this very period when Kant repudiated evolutionism with the tremulous emotion of a child frightened by a hobgoblin, the idea of evolution playing "the same rôle as in contemporary science."

5. *The Essay "On the Use of Teleological Principles in Philosophy."*—To the title of this article, published in 1788, the contents do not altogether closely correspond.[34] Part of it is, indeed, a prelude to the examination of the conception of purposiveness in nature given two years later in the "Kritik of Judgment"; but a greater part consists in a defence of the theories of his two papers on the idea of race against certain critics. For the purposes of the present inquiry those theories have already been sufficiently expounded. But it is worth while noting that, in the case of one of his critics, Forster, Kant supposed himself to be confronted with a definite evolutionary theory, upon which he felt obliged to pass judgment. The articles of what Kant understood to be Forster's "system" were these:

> The earth in travail, giving birth to animals and plants from her pregnant womb, fertilized by the sea-slime; a consequent multiplicity of local originations of organic species, Africa having its own separate species of men (the negroes), Asia another, and so on; as a deduction from these assumptions, the relationship of all organic species in an imperceptibly graded series, from man to the whale, and so backward (conjecturally even to the lichens and mosses)—and a relationship not of similarity merely, but of actual derivation from a common stock.[35]

[34] There is a reference to the species question in a fragment in the "Lose Blätter" (I., 137 f.), assigned by Reicke to 1787. This is probably merely a draft for part of the essay here considered. The fragment is in the usual vein; Kant speaks in it, for example, of "the inconceivable constancy of species, in the midst of so many causes affecting them and modifying their development."

[35] Kant's language clearly seems to ascribe these ideas to Forster, but quite without justification from anything in Forster's article. So far from fathering this system, Forster mentions it as an example of an over-ambitious hypothesis, beyond the reach of verification by man, and therefore beyond the limits of true science ("Teutsche Merkur," 1786, pp. 57–86, 150–166). And in his "Kleine

On this Kant remarks as follows:

> These ideas will not, indeed, cause the investigator of nature to shrink back from before them with a shudder, as from before a monstrosity[36] (for there are many who have played with them for a time, though only to give them up as unprofitable). But the investigator *will* be frightened away from them upon a serious scrutiny, by a fear lest he be lured by them from the fertile fields of natural science to wander in the wilderness of metaphysics. And for my part I confess to a not unmanly terror in the presence of anything which sets the reason loose from its first and fundamental principles and permits it to rove in the boundless realms of imagination.

Kant's alarm, it is evident, was aroused by all three of the hypotheses which he ascribed to Forster. But he particularly disapproved of any attempt to inquire into the origin, the laws of genesis, of organisms in general, or of the original "stock" from which any species is descended. Such inquiries "lie beyond the province of any possible physical science." For science is competent to discover only relations of efficient causation; but organisms, being material systems "in which every part is at once cause and effect of every other part," admit only of "a teleological, not at all of a physico-mechanical, mode of explanation."

6. *The "Kritik of Judgment."*—The principal source of the belief that Kant was an evolutionist in biology is a celebrated passage in the "Kritik of Judgment" (1790), § 80. This passage is, unfortunately, usually quoted with its most important part—an appended foot-note—omitted. That Kant's true position may clearly appear (in so far as a position which is involved in a scheme of elaborate self-contradictions can ever be clear), it is necessary to cite the text here nearly in full:

> It is praiseworthy to go through the great creation of organized natures with the aid of comparative anatomy, in order to see whether there may not be in it something resembling a system, even in the principle of generation of such beings. For otherwise . . . we are obliged to give up in discouragement all pretension to *natural insight* in this field. The agreement of so many species of animals in a certain common plan which appears to underlie not only their skeletal structure but also the arrangement of their other parts—so that, upon the basis of an original outline of wonderful simplicity a great variety of species could be produced merely by the shortening of one member and the lengthening of another, the diminution of this part and the elaboration of that—all this gives our minds a ray, though a feeble ray, of hope that something may here really be done with the principle of the mechanism of nature—apart from which there can be no natural science as such. This similarity of forms—so great that, amidst all their diversity, they seem to have been produced according to a common original type—gives force to the surmise of an actual relationship between them, by virtue of their generation by one primal mother (*Urmutter*) —through the gradual approximation of one animal species to another, from that in which the principle of purposiveness seems best established, *i. e.*, man,

Schriften," III., p. 335, Forster emphatically asserts the immutability of "the principal features of the primitive form (*Urbild*) of every species."

[36] Kant refers to a passage of Forster's in which these expressions are jestingly used. But, as it happens, they were originally Kant's own expressions, occurring in the review of Herder's "Ideen," already cited.

down to the polyp, and from this even to the mosses and lichens, and, finally, down to the lowest stage of nature known to us, namely, to crude matter; from which matter and its forces, according to mechanical laws, . . . the entire system of nature (which in organized beings is to us so incomprehensible that we feel constrained to think another principle for it) seems to descend.[37]

Here it remains open to the *archeologist of nature* to derive from the surviving traces of her earliest revolutions, according to any natural mechanism known to him or conjectured by him, the whole of that great family of creatures (for so we should have (*müsste*) to think of it, if the above-mentioned relationship is to have any ground). He can suppose the womb of Mother Earth . . . to have given birth at first to creatures of less purposive form; these in turn to have brought forth others (*diese wiederum andere* [*Geschöpfe*] *gebären lassen*) better adapted to the places where they originated and to their relations with one another; until finally Nature's womb, grown torpid and ossified, produced only species that underwent no further modifications; so that the number of species from that time forward remained just what it was at the moment when Nature's potency in the production of forms reached its end. Only, he must still in the end ascribe to this universal mother an organization purposively predisposed for the production of all these creatures. Otherwise the purposiveness of form characteristic of the products of the animal and vegetable kingdoms would be inconceivable.

Now this passage, though it painstakingly avoids all positive affirmation, doubtless sounds as if Kant intended by it, if not to indicate his own conversion to transformism, at least to issue to others a dispensation to embrace that doctrine. But the following note, attached to the end of the second paragraph, puts a different face upon the matter:

We may call a hypothesis of this kind a daring adventure (*ein gewagtes Abenteuer*) of the reason; there are doubtless few investigators of Nature, even of the most acute minds, to whom the hypothesis has not at times presented itself. For *absurd* it is not—in the sense in which *generatio æquivoca*—the production of an organized being through the mechanism of crude, inorganic matter—is absurd. It would after all be a case of *generatio univoca*, in the most general sense of the word, since the hypothesis supposes that every organism is derived from another organism, though the one may differ from the other in species; as if, for example, certain water-animals transformed themselves little by little into marsh-animals and these in turn, after some generations, into land-animals. *A priori*, in the judgment of reason alone, there is nothing self-contradictory in this. Only, experience shows no example of such a thing. According to experience, all generation is not only *generatio univoca* (in contrast with generation of the organic out of the inorganic), but also *generatio homonima*, in which the parent produces progeny having the same organization as itself. *Generatio heteronima* [*i. e.*, transformation of species], so far as our knowledge of Nature through experience reaches, is nowhere found.

This is certainly not the language of a believer, still less that of an advocate. True, Kant's position has significantly changed since two years previous. He has at last fairly discriminated the question concerning transformation from that concerning equivocal generation, and

[37] The entire hypothesis mentioned down to this point, it will presently appear, Kant really rejects as not only untrue but absurd. For it is a hypothesis implying "equivocal generation" and the reducibility of organic processes to mechanical laws.

has learned that the admission of a common descent of different organic species is not necessarily inconsistent either with his hypothesis of "purposive predispositions" or with those doctrines of the completely teleological character of organisms, and of their independence of all merely external causes of modification, which that hypothesis was designed to safeguard. He no longer condemns transformism on *a priori* grounds as a philosophical monstrosity. Its truth or falsity becomes a question to be settled by empirical evidence. But he also appears to say as plainly as possible that all the known empirical evidence is against the theory. No contemporary of Kant's, reading this passage in the "Kritik of Judgment" as a whole, was likely to find in it encouragement to risk that "bold adventure of the reason" of which it speaks. Moreover, in the next section of the "Kritik of Judgment" (§ 81) Kant, in discussing various embryological hypotheses, unmistakably gives his own endorsement to the opinion that "the Supreme Cause of the world . . . would, in the original products of its wisdom, have supplied merely the predispositions by which an organic being produces another of like kind and the species perpetually maintains itself." Throughout the remarks upon embryology contained in this section Kant seems to take the constancy of specific forms for granted.[38]

The chief topic of this second or biological part of the "Kritik of Judgment" is, of course, that question which had been present to Kant's mind ever since his adoption of a theory of the evolution of the inorganic world "according to mechanical laws." Could organisms also be mechanistically "explained," or only teleologically? It would require too much space to set forth and discuss adequately Kant's extremely diverse utterances on this question in his last important treatise. But when all those utterances are considered together, they do not seem to indicate any essential departure from the position which we have found him all along maintaining. It is true that he now insists with the utmost emphasis that without the conception of mechanism there is no such thing as science. "It is infinitely important for reason, in its explanation of Nature's processes of production . . . not to pass beyond the mechanism of Nature" (§ 78). He even declares that "apart from causality according to mechanical laws organisms would not be products of Nature at all" (§ 81). But he also continues with equal emphasis to insist that "absolutely no human reason (in

[38] Brock in commenting upon § 80 of the "Kritik of Judgment" observes that Kant takes cognizance directly only of the hypothesis of saltatory mutation, and is silent concerning the possibility of transformation through the summation of slight individual variations. This remark seems to me scarcely justified by Kant's language. By *generatio heteronima* he means the change of one species "little by little" (*nach und nach*) into another; though he evidently had only vague ideas of the rate at which, and the mode in which, this change might be supposed by the partisans of transformism to take place. (Cf. Brock in *Biol. Centralblatt*, Bd. 8, p. 644.)

fact, no finite reason like ours in quality, however much it may surpass it in degree) can hope to understand the production of even a blade of grass by mere mechanical causes. . . . It is absolutely impossible for us to derive from Nature itself grounds of explanation for purposive combinations," such as living beings are (§ 78). In short, we *must* regard organisms as part of the cosmic mechanism; and we *can not* so regard them. How these two assertions are to be harmonized is a thing "which our reason does not comprehend. It lies in the supersensible substrate of Nature, of which we can determine nothing positive, except that it is the being-in-itself of which we merely know the appearance" (§ 81). Kant, in short, had by this time acquired the vicious habit of affirming both sides of a contradiction and leaving it to "the supersensible" to reconcile them. Passages from the last "Kritik" may therefore be cited which seem to conflict with his earlier assertions of a sheer gap between the inorganic—the realm of mechanism—and the organic—the realm of teleology. But equally copious, or more copious, repetitions of those assertions may also be found. And upon the definite question of the possibility of "equivocal generation," Kant, as the foot-note already cited shows, remained true to his often-repeated opinion; the very notion of such a thing was to him an absurdity.

7. *The "Anthropology" of 1798.*—In his seventy-fourth year Kant returned to the subject of anthropology. His "Anthropologie in pragmatischer Hinsicht" does not, indeed, deal chiefly with the questions to which his earlier anthropological writings are devoted; the greater part of it is a rather miscellaneous but not uninteresting combination of his "critical" psychology and ethics with the purely temperamental convictions, tastes and prejudices of a septuagenarian bachelor professor, on matters of every-day life and social intercourse. Thus we find laid down, quite as a maxim of applied science, the practical observation that "eating alone (*solipsismus convictorii*) is not healthy for philosophers," though relatively harmless for mathematicians and historians. Any *philosophirende Gelehrten* inclined to the practise of dining in solitude will surely desist when they learn that they are thereby falling into *solipsismus convictorii.* The "Anthropologie" contains, however (in a footnote), one curious passage which has sometimes been quoted as evidence of Kant's acceptance of transformism. The human infant, Kant observes, comes into the world with a cry. This is characteristic of no other animal; and since it must, so long as man remained in the wild state, have been dangerous to both mother and child (by inviting attack from other animals),

> **We must suppose that in the primitive epoch of nature with respect to this class of animals . . . this outcry of the new-born was unknown, and that there subsequently supervened a second epoch, in which both parents had attained the degree of civilization necessary for the household life. . . . This remark carries us far; for example, it suggests the thought whether this second epoch might**

not, on the occasion of some great revolutions of nature, be followed by a third —an epoch in which an orang-outang or a chimpanzee should perfect the organs which serve for walking, touching, speaking, into the articulated structure of a human being, with a central organ for the use of the understanding, and should gradually develop itself through social culture.

Only to a superficial reading can this passage exhibit Kant in the guise of an evolutionist in biology. For, in the first place, there is no indication that he conceives even these extensive modifications of form and function as transforming the animals of which he speaks into new "natural" species, in his own sense of that term. In the second place, the passage does not suggest that the *existing* human species is descended from the apes. For in the "second epoch" mentioned, we already find our human ancestors living the household life; and the "third epoch," characterized by such striking improvements in the orang-outang and the chimpanzee, is subsequent to the second, and, in fact, still in the future.[39] Finally, even to this hopeful anticipation of a "good time coming" for the apes at some future "revolution of nature," Kant does not really subscribe; he merely expresses some passing wonder whether something of the sort "might not" occur. As a matter of fact, his publication of so vague and inept a passage as this after Maupertuis, Buffon, Diderot, Erasmus Darwin and Goethe[40] had written, shows that in his declining years he had not lost that constitutional aversion from the proper hypothesis of organic evolution which we have found to be characteristic of him from the beginning of his career. Also from the beginning, it is true, we have seen in him, as we see here, a constant vague inclination towards evolutionistic modes of thought. But through all that half-century, which constituted the period of the true beginnings of biological evolutionism Kant, our analysis has shown, never once professed belief in the transformist; nor did he ever show an ability to apprehend clearly either the precise meaning or the force of the considerations which could even then be adduced in favor of that doctrine.

[39] Only by disregarding the natural construction of Kant's language can the sentence about the "third epoch" be interpreted as referring to past time. Wallace (from whose skilful rendering of the passage I have borrowed some phrases) asks: "Has Kant cautiously put the future instead of the past, and hinted at what probably has been rather than what may one day be?" ("Kant," p. 115.) But why should Kant in 1798 have felt obliged to hint so obliquely at an idea familiar to his contemporaries for half a century, which Buffon had hinted at a good deal more plainly, and several celebrated writers had adopted? The desire to avoid theological opprobrium could hardly have been a motive for taking so evasive and misleading a way of imparting his real view. For theological opprobrium was as likely to attach to certain opinions which he frankly accepted—and probably to the hypothesis of the *future* transformation of apes into rational beings—as to the hypothesis of their past transformation.

[40] Goethe's first unequivocally evolutionary utterance seems to be found in his "Vorträge über die . . . allgemeine Einleitung in die vergleichende Anatomie," 1796. Cf. Wasielewski, "Goethe und die Deseendenzlehre," p. 27.

UNIVERSITY REFORMS

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AT present there is a wide-spread popular interest in all questions relating to the subject of educational reform, and it may be said with truth of the public, "Thou criest after knowledge and liftest up thy voice for understanding." The discussion is general and not limited to any one locality, nor confined to any particular social class. Over their cups of afternoon tea Mrs. Jones discusses with Mrs. Brown the respective merits of different educational systems, and at the club many an old graduate is up in arms at the mere suggestion that the boys at college are now made to spend too much time over their books! College presidents in their public utterances are decidedly optimistic in regard to the prospective value of this or that proposed change in the curriculum as hastening the day when the colts driven to water will drink eagerly from the fount of knowledge. It is fortunate that the note of optimism has been so loudly sounded by prominent educators, for only those who set out with hope may keep the road across the plain in which lies many a miry "slough of despond."

The task of a university president is no sinecure. The public, which includes many fond parents, is beginning vaguely to realize that something is wrong with our educational system, and as many a boy about to graduate from the university fails to appreciate the value of culture and has no overwhelming love for learning, it is only natural that the parental disappointment should attribute the failure to the last person controlling the throttle of the educational machine, namely the college president. At once the system is blamed, changes are proposed, new hopes are aroused, a general culture is promised, the elective system is dropped, courses are prescribed, the boys are forced to work, and then believing a panacea has been found the public temporarily loses interest in the discussion.

Again the machine grinds on until some one makes the discovery that the majority of the undergraduates do not read "Culture and Anarchy," nor do their copies of the "Novum Organum" show signs of being well-thumbed. The wave of public interest rises again and breaks with such force that the foundations of more than one institution of learning are shaken. The army of the Philistines not having been routed by the frontal attack, strategy is substituted for force, and with the same generals in command a flanking movement is planned. The functions of the brain and nervous system are to be properly

adjusted to respond to each and every wave of truth by surrounding the scholars with influences so subtle that unconsciously they are to become inoculated with culture and the love of learning. Experience teaches us, however, that this method of instruction generally produces one of two types of scholars—the savant for vanity "who is quite satisfied with the honor of being regarded as a curiosity himself" or the savant for amusement "who loves to look for knots in knowledge and to untie them, not too energetically, however, lest he lose the spirit of the game." Some of those who in a general way have been the most alert to apprehend the existence of defects in the educational system, without being able to localize the exact seat of the trouble in the machinery, have at times attributed the specific faults to the general tendency to introduce into the curriculum the study of purely utilitarian subjects. This view assumes that useful knowledge is vulgar and has no relation to culture, but fails to recognize the importance of emphasizing, not the subject studied, but the methods of work acquired. While many persons take an active interest in the discussion of the general problems of education, very few seem to appreciate that the acquisition of either culture or learning implies the subjection of the most complicated and delicately balanced organ of the human body, the brain, to a series of protracted tests and strains of considerable intensity. The general attitude of the public to the whole subject of education is very well expressed in the lines of Goethe:

> **Mein Kind ich habe es klug gemacht**
> **Ich habe nie über das Denken gedacht.**

In spite of the growing interest in the subject it is becoming more and more difficult to find an accurate definition of education, because each individual has his own ideals which may be regarded as the product of his past and present environment. We judge of the merits of a given system by the finished product, the individual scholar, and we argue in favor of the humanities, or of the sciences as the case may be, merely because certain types of scholars appeal to our personal predilections. We are apt to attribute the possession of the mental traits of those individuals who by their attainments represent the personification of our ideals to some special system of education (belonging to some school, college or university), quite forgetful of the fact that various subtle influences, such as heredity and environment, have been the most potent factors in determining the final result. An education, even if wisely planned and well directed, adds nothing to the natural brain power of the individual; it merely gives his latent faculties an opportunity to develop to their highest point of efficiency. If we could add one jot to the latent capacity of any scholar's brain there would still be hopes of making the silken purse from the sow's ear.

We find one person the possessor of a certain kind of knowledge and

hastily draw the inference that the mere acquisition of a similar store will bring out identical mental traits in other individuals irrespective of their mental capacity. This point of view has unfortunately given rise to an excessive faith in the special potency of certain kinds of knowledge, and has engendered a sentimental belief in the educational value of first one and then another subject. As a matter of fact, experiences teach us there is only one kind of knowledge and one way of acquiring it. The general tendency of educators to prescribe definite mental tasks in order to increase the efficiency of an organ whose functions they have never seriously studied is analogous to the practise of the physicians of the old school with their inordinate faith in the specific power of a large number of drugs to cure diseases. There is no reason for supposing that a professor of Greek or chemistry should be more capable of estimating the capacity of an individual student's brain than there was for the barbers in the reign of Henry the Eighth assuming that they possessed sufficient knowledge of the anatomy of the human body to entitle them to perform the duties of general surgeons.

No matter how much intelligent persons may differ in their expressions of belief as to the relative merits of educational systems, there is a general agreement as to the nature of the distinctive differences between past and present systems; the former laying stress upon the character of the information gained, the latter emphasizing the importance of the mental habits acquired. The results aimed at by modern education have been well defined by Ex-President Eliot as "an initiation of mental processes and the establishment of good mental habits, with incidental acquisition of information"; and according to President Lowell "the essence of a liberal education consists in an attitude of mind." From this it may be seen that the importance of good mental habits or, if we choose to express the same idea physiologically, of a well-balanced brain is an essential factor in the pursuit of culture; for although we may get to know the best which has been thought and said in the world, we must still have the power "to turn a stream of fresh and free thought upon our stock notions and habits." If we start out from this physiological point of departure the absurdity and irrelevancy of much of the talk at the present time as to what should and should not be taught in the universities is apparent. When an individual has acquired bad habits of eating, bolts his food and develops symptoms of acute indigestion, he is not generally advised to eat more, but is told to learn how to chew and to eat less. Most of the boys who enter the universities have suffered from one or more attacks of mental dyspepsia; through no fault of their own they have acquired bad mental habits, and nature has made an attempt to readjust their mental balance by giving them a distaste for more food. But, in order to sell the

stocks in the educational shop, still more food is prescribed. The bad mental habits become worse and the only redeeming feature is that, in the attempt to get a general culture, so many different kind of pills are prescribed that the fatal dose of any one is never administered.

When the mental balance of an individual becomes so distorted that the currents of thought always run in certain grooves, from which they never emerge and there seems to be no hope of readjustment, such a person is said to be the subject of "fixed ideas" and then the educator is only too anxious to disclaim all responsibility in the patient and shift it to the alienist. In view of the fact that more and more emphasis is being placed by prominent authorities on educational subjects upon the necessity of insisting upon the importance of the formation of good mental habits, we may ask whether any well-organized effort is being made by the universities to determine the conditions upon which the greatest efficiency of brain activity depends; and then to use this knowledge to arouse and train the potential mental capacity of the students, so as to produce men with sound minds and sound bodies.

When we approach the discussion of our subject from this standpoint, it is quite obvious that the first and most important questions to be asked relate to the methods to be adopted in training the brain; and second, and quite incidental, to the character of the information to be imparted. It is the first of these two subjects that we shall concern ourselves at present. No matter how much we may differ as to the value of educational ideals, all are pretty well agreed that there are certain definite readily recognized qualities of mind possessed by the educated person. First, there is general intelligence with a marked degree of associative memory, a certain poise or balance commonly designated as good judgment and a tentative rather than a fixed attitude towards knowledge, a capacity for concentrating the attention, a quota of emotional activity well under control and a dominant will. Science has taught us that these mental traits are an expression of the functions of the nervous system, and in order to understand them properly, they should be studied as the quantitative and qualitative measure of the individual capacity of the brain. No intelligent person to-day questions the fact that the more marked anomalies of cerebral function, as seen in idiocy, imbecility and the various forms of psychoses, can be analyzed and correctly interpreted only by those who have had the requisite special training and experience in connection with the study of the brain. With a singular disregard for logic and common sense, many intelligent persons assume that special skill and experience is not necessary in order to analyze the subtler and less defined anomalies of conduct as revealed in the daily life of normal individuals; nor is any intimate knowledge of the structure and func-

tions of the brain considered essential to those whose duty it is to bring this organ to its highest state of efficiency.

For various reasons, which it is not necessary to recapitulate, investigators interested in the study of the functions of the brain have at all times found themselves more or less in conflict with many of the accepted philosophical theories that served to obscure the issues and make progress difficult. King Frederick William's antagonism to the new ideas introduced by science into the study of psychology is a historic example of the difficulties which popular prejudice has created. This sovereign's refusal to believe in the application of the law of cause and effect to the study of mental phenomena, because he would thus be deprived of logical reasons for punishing the deserters from his Grenadier Guards, finds many analogies even at the present day.

All forms of conduct in the higher as well as the lower organisms are an expression and measure of the functional capacity of the nervous system. From the protozoa to man we can follow the constantly increasing complexity of function as revealed to us in behavior without being able to pick out a single trait as specifically characteristic of any particular organism. Herrick has called attention in a very interesting way to the fact that animals widely separated from each other in the scale of functional and structural complexity, as the annelid worms and the vertebrates, present striking differences in behavior referable to the contrasted types of nervous system represented in these two groups. The behavior of the former, stereotyped and predetermined, may be inferred from the structure just as the "plastic individual reactions of the intelligent type" are dependent upon special arrangement of the nervous mechanism of the latter. Between these two extremes are countless gradations in conduct as well as in the arrangement of the nervous system. The prevailing ignorance in regard to facts of the most elementary character relating to the structure and functions of the nervous system is well illustrated by the remarks of an English acquaintance, a graduate of Oxford and a recognized ecclesiastical authority upon matters of conduct, who when told, in reply to an inquiry, that fish had brains, after a brief period of meditation replied, "Really, that's quite an idea." What a strange comment upon our present methods of education that an individual altogether ignorant of the structural and functional capacity of the brain of a fish, which differs from the human brain only in the simpler arrangement of its elements and the greater limitation of its functions, should be considered an authority upon the training of the most complicated nervous system in the whole animal series!

The dawn of consciousness, the simplest form of memory, the element of choice in volitional acts, appear far down in the scale of living creatures, and this law of recapitulation in the behavior of organisms is

repeated step for step in the life history of each individual. From the first movements of the embryo until the adult has reached the prime of development, the line of progressive functional development is unbroken. In the earlier studies made upon the brain local lesions such as those caused by apoplexy, injury, tumors, etc., were the first to attract and interest the public as well as physicians. It was much more difficult to understand the diseases of the brain not dependent upon localizable lesions, but gradually a way was found leading to a better understanding and clearer analysis of the mental disturbances occurring without discoverable lesions. But the brain is so complicated an organ that a slight interference with its mechanism may give rise to complicated functional disorders involving the entire personality. As a matter of fact comparatively little is yet known in regard to the cumulative effect of disturbances in the mental activity incident to relatively small lesions in the higher brain centers. In the study of the various psychoses the alienist has found a complete analogy to the results obtained in the study of the comparative physiology of the brain. When the attempt was made to analyze the anomalies of conduct in the insane it became evident that no distinctive qualitative difference separated them in behavior from normal individuals. In the daily ups and downs of the ordinary life are found the basis of the pathological conditions known as manic-depressive insanity, while in the precocious bizarre habits of young people and children are recognized the germs of that sad group of cases known as dementia præcox. In the rigid inflexible opinions so frequently expressed in the discussion of religious or political questions we find the key explaining the stand-pat positions of individuals subject to chronic systematized insane ideas.

The individuals showing a particular bias, or those inoculated with the spirit of excessive partisanship, the sentimentalists, the whole host of faddists, the doctrinaires, the obstinate and the bigots to a certain extent reflect but to a less degree some of the mental traits of the paranoiac. The permanence and intensity given to certain ideas have been the result of the emotional storms attending their appearance in consciousness, and in the latter condition, where a marked psychosis has intervened, the intense emotional reaction has subsided and the idea has crystallized out of its setting. In the normal individual when one function of the brain is nicely balanced against the other the analysis of behavior is, as a rule, more difficult than it is in the insane in whom the exaggeration of different traits of character becomes so marked that a clue as to their origin and development is given.

In the history of psychology it is particularly interesting to note that practically every advance made in this department has followed close upon the incorporation of the conceptions and terms of natural science; and it is equally obvious that the delays and regressions have

been due to that general tendency to give up the study of particulars, and as Bacon puts it, "to view nature as from an eminence." It was this tendency which induced Kant, after having started in the right direction, to affirm that the development of man's moral and intellectual nature lies beyond the problems of natural science.

Sufficient has been said to emphasize the great importance of the study of the brain and nervous system as the only effective way of establishing a more rational system of education. The most important consideration in the whole field of education is not the discussion of methods for conferring the present opportunities indiscriminately, so that all may avail themselves of them, but rather to determine how the educational system may be modified to meet the needs of each individual. Gradually the public is beginning to awaken to the fact that a so-called higher education may not only fail to act as a panacea for all human ills, but may become a potent factor in increasing the mental and physical degeneration of the race. An overtaxed brain and nervous system may not only be followed by a nervous breakdown, but it may expose its possessor to temptations which seriously interfere with his morality. It will be a fortunate day for the community when it appreciates that a sound morality depends not so much upon an individual obeying the dictates of philosopher or priest as in following out the injunctions of the physician.

So far as I am aware, Dr. Adolf Meyer was the first to offer the suggestion that departments of mental hygiene should be established in all our universities where advice could be given to teacher and student upon questions relating to the training of the brain and nervous system to the limit of the individual capacity as estimated by competent persons, so that these limits should not be exceeded. In this way it would become possible to gradually train teachers who would be competent to form a correct judgment as to the quality of each student's mind and the futility of attempting to estimate the mental capacity by the amount of information acquired would be more generally recognized. The present system of tests generally represented by written examinations is an incentive to encourage memorizing, but is a serious obstacle to logical thinking. The mechanical memory is frequently an evidence not of intelligence, but of certain forms of imbecility. An examination conducted along the lines suggested leading to a qualitative estimate of a particular student's mental capacity would not be a difficult task for those who have had the proper training. Any intelligent physician skilled in the methods of modern psychiatry could in a comparatively short time form a relatively accurate conception of the qualitative character of the mental processes of an individual under observation. Frequently common sense alone, but more often when combined with a desire to profit by the financial aid given by life-insurance companies,

is a potent factor in inducing individuals to seek medical advice in regard to the care of the heart, lungs and other parts of the body; but one organ, the most delicate of all, the brain, is sadly neglected, until some already well developed disease has compelled the patient to seek the advice of the specialist. In our schools and colleges considerable attention is now being given to the prevention of those having weak hearts or lungs from taking part in athletic contests, whereas at the same time practically no attempt is made to discourage those with functionally impaired nervous systems from undergoing the excessive tests imposed upon them by the strain of a modern education. On the contrary, every attempt is being made to induce all, the unfit as well as the fit, to pass through the educational mill. Those who fail become objects of pity, even if they keep out of the police courts and do not end their careers by suicide.[1] If the latter event terminates their career, those concerned in the general carrying into effect of the campaign of an education, which has given rise to such remote but undesirable consequences, are not even indirectly blamed, whereas the individual's memory is frequently anathematized by ecclesiastical authority and his or her mortal remains are refused burial in consecrated ground. The public's indifference to the importance of this general question of the introduction of a more rational system of education is commended by Mrs. Grundy. If it were not for the influence of this lady it would be possible to subject each student during his college or university days to an examination to determine whether his sense perceptions were below normal, his memory defective, his power of the association of ideas impaired and his volitional control diminished, with the object of giving intelligent advice to correct, if possible, the deficiencies, thereby increasing the individual's sphere of usefulness, and in many cases averting by these precautionary measures a complete breakdown.

One of the reasons why educational psychology has not fulfilled the predictions made for it by its most enthusiastic supporters, may be referred to its failure to recognize the value of a principle of fundamental importance which directs our attention to the necessity of the study of the brain in its relation to other organs. The idea of the possibility of isolating and studying the functions of the brain analytically quite apart from the phenomena occurring antecedent to the appearance of ideas in consciousness, and conditioned by the activity of heart, lungs, liver and other organs, is an unfortunate persistence of that form of the dualistic conception of the relation of mind and body which has so long delayed enquiry in this field. Though it is always dangerous in the development of any new department to awaken public interest by promising immediate results of importance, a good deal of information of practical value could be disseminated which would tend

[1] In the year 1908 there were some 8,332 deaths from suicide in the United States.

toward the reorganization of the curriculum in our higher institutions of learning. The number and grouping of subjects in the different courses of study now generally followed in most of our schools and colleges represent the selection brought about by the natural development of an educational system in which the chief aim has been to impart information rather than to supply the means for bringing the functional capacity of each individual brain to its greatest efficiency. To those who have had experience in studying the mental phenomena of individuals, it is apparent that the great number of subjects now crowded into university courses, can only result in giving many of the students mental indigestion. This is one of the reasons why so many young men leave college or the university without, apparently at least, having gained any real intellectual pleasure from the work which they have undertaken. There is an apparent indifference to higher ideals, while the feeling of pleasure which should be associated with normal mental activity is quite lacking, as a result of the surfeiting during the school and college days. The constant effort made by the student to readjust his mental focus upon first one and then another subject dissipates energy, destroys initiative and gives rise to a certain ennui which is one of the first symptoms of fatigue.

The apparent but not real lack of originality in American students, and their inability to work out problems which require long-continued effort in one direction are referable not to any inefficiency on the part of the student, but are the result of the system of education to which they have unfortunately been subjected and that is quite lacking in discipline. The physiologist early appreciates that under the present curriculum of study in our universities so many subjects are introduced that it is only possible for an individual to acquire information in regard to the great variety of topics, but no time remains for him to be drilled in the mental discipline essential to the formation of good mental habits. Few students are ever given time, even if they have the inclination, to follow Newton's precept of thinking long upon one subject or to imitate Darwin's example of keeping a subject in mind for a number of years without ever losing sight of it. Modern education is undoubtedly defective in depriving the student of the time and the incentive to prolonged meditation, an absolute essential to great achievement.

In connection with the work of the department referred to, advice could be given in individual cases with the view of correcting functional disturbances of the mental activities, such as inattention, anomalies of the will, and other impediments to education.

The important part played by slight physical deformities in the development of the personality was clearly shown by a French throat specialist, who years ago made the interesting observation that when-

ever there was any obstruction to the drawing in of air through the nasal passages it was extremely difficult for the individual, thus afflicted, to focus his attention for any considerable length of time upon any one subject. Since the days of Krishaber, great numbers of other physical causes have been found which, if not removed, may greatly impair the dynamic power of the attention even if the cause is slight. The general irritability and fretfulness of children with defective vision or enlarged tonsils, the malaise and apparent laziness so frequently a symptom of anæmia or neurasthenic states, the emotional outbreaks of temper, the destructiveness, the grimacing and the tics of St. Vitus' dance, the abnormal imagination, the tendency to lying, precocity and self-centeredness in hysteria, are symptoms which, if exaggerated, should be regarded as signs of immediate danger to the individual, but even when less pronounced they often become the danger signals indicating a serious but slow degeneration in the mental and moral development of the child. The important point to be born in mind in this connection is that an almost inappreciable defect in the mental activity of an individual, if persistent for a long period of years, may ultimately result in profound changes of the entire personality. This is not only true in regard to defects in capacity for attention, but is equally true in regard to the still more important functions of feeling and will. As an example we may cite the popular conception, to which expression is so frequently given, that a young man should not work too hard during his university days. This notion takes no cognizance of the fact that the sloppy mental processes following a protracted period of mental inactivity make it impossible later for the individual to direct his own thoughts. One of the chief lessons taught by modern psychiatry is that the persons the most subject to mental disturbances are those who early in life have failed to form good mental habits. Individuals do not break down as the result of hard work, but failure comes from the inability to adapt their mental processes to the new conditions in which they have frequently been cast and by the sudden strain put upon the brain whose functions have deteriorated through inactivity. The attempt of the indolent to find an intellectual justification for their sins of omission is in direct opposition to the doctrines of physiology, which teach us that the strength of any organ is increased by the proper exercise of its functions. This is a lesson which should be taught to students in our universities, and a few hints should at the same time be given as to the methods of work to be adopted, after which the students should be encouraged to go forward themselves.

The importance of emphasizing the cultivation of a healthy initiative in thought, as well as action, is a subject upon which there is apparently little opportunity for disagreement among intelligent persons; and yet many forces operating at present are antagonistic to the de-

velopment in students of this important mental trait. There is a very specious form of individualism which is frequently mistaken for independence and originality in thinking. The former is characterized by lawlessness and an assumed disregard for the ordinary laws of thought and conduct. In the events of ordinary life such fools rush in where angels fear to tread, whereas the initiative developed by a sane and effective process of education is analogous to the strong man's desire to run a race, reasonably conscious of his power to vanquish his competitors. But unfortunately in most of our universities real originality is repressed, or often killed by the curriculum, conventionalities and petty criticism. Students are easily forced into the class of people described by Mill as liking things in crowds. They are seldom compelled to exercise their own senses, and a mass of ready-made judgments upon literary and historical subjects is heaped upon them before they can stand straight, their own ideas being dwarfed and eradicated in order to make room for the borrowed knowledge. It would be as novel as instructive to hear a professor address his students as follows:

> Young Gentlemen, I advise most of you not to attend my course in history, but to substitute for it some form of instruction where you will be compelled to exercise your own eyes. Take a course in drawing, or of nature study, learn to see things, to form your own judgments, and when you have shown your ability to collect data and to form an independent opinion as to the relation and value of particulars, I will then give you my own and the views of others upon historical questions.

Students are very frequently so impressed by their instructors with the importance of imbibing knowledge that they fail to scrutinize the information given them and thus readily lapse into a condition in which no resistance is offered to the forced feeding. And if the process is continued, a positive distaste for knowledge is developed. Leonardo da Vinci clearly recognized this plethoric state of mind, for he admonished his readers that "just as food eaten without appetite is a tedious nourishment, so does study without zeal damage the memory by not assimilating what it absorbs."

Payot in his "Education of the Will" affirms that the more brilliant a professor is and the more he enjoys hearing himself talk and argue, the less desirable does it become to confide young people to him for instruction, for he gives as little aid in assisting them to acquire the art of working or in making true progress in scientific work as one would bring about a gain in muscle and skill in gymnastics by watching the strong man at a circus.

Closely associated with the question of the choice of methods for the development of the individuality and the capacity of adapting the mental focus so as to include more objects within the field of vision is the removal of all influences tending to limit the horizon and to breed those disorders of personality popularly described as narrow-minded-

ness, bigotry and the like. It does not take any special knowledge of the study of mental disorders to recognize some of the chief defects in the present system of organization of our universities which tend seriously to upset the mental balance of teachers and students. A hysterical sentimentalism unfortunately associated with the spread of the "college spirit," has become very intolerant of criticism and when placed upon the defensive immediately resents any suggestion of proposed change in a curriculum "which was quite good enough for our fathers." Generally speaking, conservative Princetonians are amused when the incident is mentioned of that loyal son of Harvard who having found his passage taken on the S. S. *Yale* waited over one entire day in New York in order to return to Boston by the S. S. *Harvard.* One has to go to New Haven, Cambridge or Baltimore, however, to find those who appreciate the concealed humor in the speech of the Princeton alumnus who openly advocated making the attempt to keep Princeton ideals uninfluenced by outsiders and the faculty composed of Princeton men! One of the greatest dangers threatening the development of American universities is the tendency shown to sacrifice individual development in the attempt to advance the interests of a single institution. In European universities, particularly those in Germany, Austria, Switzerland and northern Italy, when two candidates are proposed for election to a professorship, the call is generally given to the outsider. This custom supplies an excellent corrective inhibiting the development of those fixed ideas existing in all communities where the teaching authority is the *lex populi.* An excellent estimate may generally be formed of the professional standing of a teacher by the number of "calls" he receives from other institutions.

Unfortunately in faculties where complete harmony exists the dangers of the growth of the spirit of mutual admiration becomes a menace to healthy mental activity. The objectionable spirit of partisanship is frequently more marked in the professional schools (theology, medicine, law) than it is in the academic departments of the universities. Eternal vigilance is the price to be paid for intellectual as well as political liberty. The method generally adopted in a university of electing a board of trustees entirely recruited from its own alumni without any representatives from other institutions is unfortunate, because the members will almost certainly be guided by a sentimental interest in the affairs of a single institution, rather than by an intelligent appreciation of the intellectual needs of the entire country. The effect, even indirectly, upon the teaching and student body of the selection of a board whose members are chosen because they are supposed to represent the spirit of a single college instead of the broader and more general interests of the national life is narrowing.

If we wish to determine the physical conditions essential to the

cultivation of the mental plasticity and poise in order the more successfully to combat all tendencies encouraging a blind reliance upon authority and fixed states of mind, we must know something about the manner in which comparatively slight deviations from the normal balance are converted into the stable systematized delusions of the insane. The alienist quickly recognizes the fact that the sentimental tendencies expressed in the uncritical devotion to the maintenance of the ideals of a single college offer a very favorable soil for the development of petty prejudices and provincial ways of thinking, the directions of our thoughts being determined by the presence of ruts, however much we may, sometimes, attempt to explain them away with all the vehemence of stand-patters. American ideals should be substituted for the Harvard, Yale or Princeton ideals, if we wish to cultivate the quick and ready discernment of the right wherever it is to be found One of the principal lessons to be forced home upon students, striving to acquire a normal physiological habit of thinking, is to impress them with the fallibility and not the infallibility of individual judgments, but when young men are encouraged to believe that the institution from which they graduate represents *the* most advanced position on the road to the intellectual Mecca, they unconsciously get a mental twist, the effects of which it is difficult to counteract.

The principles of logic and of criticism may be taught in theory, but the conditions essential to the proper selection of premises and the formation of sound judgments are still far from favorable, and this will continue as long as American students are encouraged to form general opinions altogether lacking in discrimination as to the respective merits of different institutions. The same narrowness of vision and absence of charity which have created the barriers of opinion between many of the different theological schools have unfortunately afflicted the universities. When Harvard professors begin to urge some of their students to take a year at Cornell or Columbia, in order to get into another atmosphere, or the benefit of a change to the Cambridge environment is recommended to correct the inflexible mental traits acquired on New Jersey soil, there will be reason to believe that the universities are becoming centers, whence sound advice is being disseminated as to the methods of developing sane and logical thinking. There is danger that the odium institutionum may in a measure replace the odium theologicum of earlier days. Students are often advised to take a trip abroad following graduation in order to readjust their mental foci. The blind devotion to the maintenance of a proper college spirit forbids the entertainment of a recommendation that an excellent prophylactic measure directed against the possible development of this form of institutional myopia would be a year, preferably the senior year, spent at some other American institution.

At present there is only a very vague realization even among those who call themselves teachers that the first duty in imparting instruction is to give pupils some idea of the proper methods of study. McMurry in the preface to his excellent book "How to Study and Teaching how to Study" confesses that for many years he has made this subject his hobby and adds that, after careful search, he has only been able to find two books in English and none in German on the "Art of Study." Few instructors ever give any serious attention to the development of a normal thought-mechanism in their students. Information is imparted together with a great many bad mental habits and the store of knowledge acquired is considered to be the test of the individual's mental capacity. So firmly rooted in our mind is the idea that the amount of information and not the acquisition of good mental habits is the chief end of an education, that we fail to recognize the dependence of our thoughts and actions upon the reactions of the nervous system. The tentative attitude of one person and the ready acceptance by another of articles of belief are conditions created by the responses of the nervous system to the needs of the individual. The mental traits, functional expressions of the capacity of the nervous system that make it easy for one person to believe, may in another tend to the development of an habit of mind which makes it difficult for the believer to realize that, even in matters of belief, no one is altogether right.

According to Professor William James old fogeyism begins at an earlier age than the majority of persons believe to be the case. The symptoms may appear at twenty-five. In spite of the general existence of this presenile form of deterioration, we still clamor about the necessity of a broader and more general culture, as if it were possible to correct one bad habit by substituting others. Much good would undoubtedly be accomplished by the application of the methods of modern clinical psychiatry to the study of the sources of the prejudices and various forms of intellectual intolerance which have resulted in the painfully slow progress of the human race. In the examination of patients in the clinic, a careful study of their powers of sense-perception is conducted before proceeding to an estimation of the capacity for originating and associating ideas, or for forming intellectual judgments. Our universities sanction the perversion of the normal mental activities of students by encouraging them to debate, to have a ready opinion upon many subjects, and to talk glibly in public, before they have shown any capacity to gather the data presented to consciousness by the medium of the sensory tracts (touch, taste, smell, sight, hearing) and to arrange and compare them so as to form independent judgments. Rosen in an interesting book[2] has shown us that the greatness of the old masters was due to the acuteness and accuracy of their

[2] "Die Natur in der Kunst," Leipzig, B. G. Teubner, 1903.

perceptive faculties. They were able to paint as no modern artist can, because they studied nature closely and were seldom blinded or deafened by the critics. The ennui often appearing in a student following a course of didactic lectures is the result of the forced rumination upon the very few facts which he has been given opportunity to acquire through his own efforts. Modern education is still defective in training the sense-perceptions and the continuous meditation upon the few data furnished us by our own eyes and ears produces a state of mental fatigue, so that finally the tendency to reiteration becomes as annoying as the constant effort to count the figures on the wall-paper to the fever patient, or as the blind impulse compelling the child with St. Vitus' dance to touch each telegraph pole, as he walks near it. Even if we admit the truth of the dictum that there is nothing in the intellect which was not first in the senses, we are not guided by this idea in arranging courses of study. Boys are still forcibly carried through their school and college days in the same spirit in which personally conducted parties are rushed through the Vatican galleries. As the result of the so-called liberal education, the student frequently finds that he has actually become deficient in his sense perceptions and has acquired a faulty thought-mechanism; although possibly he finds some consolation in feeling that conventionalities have been satisfied by the completion of the grand educational tour. But sometimes, when it is too late, here and there one begins to appreciate that he has eyes and can not see, ears and can not hear.

Closely associated with the ideational faculties are the phenomena collectively designated as Will. The careful study of individuals, somewhat as practised by the skilled alienist, has taught us that a great deal may be accomplished in the training of the volitional powers. The old method employed to strengthen the will was similar in many respects to the practise indulged in of teaching children how to swim by throwing them into deep water. In a few cases only was the method successful. The remarkable advances in the study of the comparative physiology of the nervous system combined with the careful analysis of the conduct of individuals made by psychologists and alienists have shown conclusively that all our volitional acts are the expression of the activities of the brain.

The old axiom predicating the existence of free will is a pure fiction. When we speak of the will custom and usage have unfortunately led us to suppose that the volitional act is a phenomenon quite unrelated to other events in our mental life. As a matter of fact, the will-act is a very complex affair, depending upon a variety of conditions. Here is an example: It is a pleasant summer-day and as I sit at my desk and write, two conflicting impulses shoot up into my field of consciousness. One tendency is strong to get up, leave my work unfinished

and take a walk in the country. The other keeps me at my desk and busy with my writing. Each impulse is the resultant of a complex of sensations, ideas, habits so involved and intricate that in the present state of our knowledge only a superficial analysis is possible; and what I shall will to do in this particular case is largely the resultant of a series of acts that have gone before. Abnormal mental states emphasize certain components in the mental chain, so that we can get an inkling of the mechanism involved in the expression of volitional choice between two motives. If it is blue Monday and I am mentally depressed, the tendency to sit still at my desk and mope is stronger than either of the other two motives, and if the depression deepens, every effort becomes difficult, the sense of the freedom of the will is reduced to the minimum, and it may be that the normal desire for food vanishes. Finally in an extreme case physicians and nurses are brought in to force the feeding and give the general treatment necessary to restore my lost energies and key me up to the pitch when simple decisions are no longer associated with an abnormal sense of effort.

Another condition may occur, and instead of being depressed, I am exhilarated. The sense of effort is diminished, action becomes easy and the sense of fatigue is absent. Impulses to action, to walk, talk, write, gesticulate, are constant. During the period of depression, I was on the earth, now I am walking on the clouds. Ideation is rapid. I dash off sentence after sentence, or I walk miles with but slight sense of fatigue. The obstacles to effort created during my period of depression vanish into thin air. A whole host of sensations of a pleasant nature stream into my consciousness and the passage from the depths of Lethe to the heights of Olympus is completed. If the depression or exhilaration surpasses certain bounds established for convenience sake by legal authorities, the analysis of motives becomes easier than in the instances where the rises and falls in the emotional life are less marked.

There is a very promising field for prophylaxis in preventing the occurrence of abnormalities in the volitional acts. One or two examples will suffice to indicate our meaning and suggest the corrections. Many of the beneficial results of athletic sports are almost entirely lost by the encouragement given to the hysterical manifestations of emotionalism, which so frequently affect the spectators even more than the participants.

The lack of practical interest in a preventive morality is shown by the university authorities who permit the members of a football team to be fed on an almost exclusive meat diet, subjected to the nervous strain of exciting games, and then when the balance of the nervous system has been suddenly upset, expect them to successfully resist the cravings created by the general system of dieting and training to which they have been subjected. When the Roman Catholic church wishes

the spiritual to preeminently dominate the carnal impulses, it becomes sufficiently materialistic in practise to advise the believer to fast or at least to substitute fish for meat in his dietary. The individual who has not learned to regulate his diet to his physical and spiritual needs and has not acquired the habit of chewing his food thoroughly, has failed to pass his elementary examination in the field of applied ethics. The physical, mental and moral deterioration beginning in the second or third generation of families which have suddenly acquired wealth may be attributed primarily to the luxurious diet no less than to the other extravagant ways of living.

Still another line of argument in favor of the universities paying more attention to the study of the brain is supplied by the mal-adjustment of great numbers of persons to the unsuitable environment into which they have been driven by the impulses and ambitions awakened by an education ill-adapted to their individual brain capacity. Public charities, missions, settlement work, are all agencies tending to alleviate some of the sufferings of mankind, but we seek in vain for the signs of any organized effort to prevent the perversion of the mental activities of great numbers of individuals which has come about from lack of proper advice and instruction in regard to the selection of an education which will not disturb the balance of the nervous system and generate undesirable impulses, exceeding the inhibitory capacity of the individual.

The number of those suffering from mental disorders is appalling. In Great Britain there are nearly 70,000 idiots, over 47,000 lunatics, 23,000 criminals, nearly 10,000 deaf and dumb from childhood, 60,000 prostitutes, 62,000 epileptics, more than 88,000 backward children and 18,000 habitual vagrants, and many of these degenerates are engaged in breeding offspring! In institutions in the United States we have more than 145,000 individuals in well-advanced stages of alienation and over 120,000 feeble-minded persons, and it is safe to assume that if all the patients suffering from psychoses were actually brought under observation, these figures would be greatly increased. The present cost to the country of partially providing for the maintenance of this army of incapables is well over $40,000,000 a year.

One of the most important functions connected with the work of a department of mental hygiene would be the encouragement given to the investigation of all questions connected with the anatomy and physiology of the nervous system, along the lines where these studies could not be prosecuted to a greater advantage in the laboratories and clinics of our medical schools. Not only in this, but in all other departments the selection of directors from among those who have shown themselves capable of carrying on original investigations should be insisted upon. Only when this spirit has permeated the whole department, from the

top to the bottom, is it possible to retain the freshness and mental vigor as essential to the teacher as it is to the investigator. The public, as a rule, does not appreciate the fact that successful teaching and investigating can not be disassociated in the university. The teacher who fails to take an active interest in research is generally deficient in his appreciation of the importance and difficulty of keeping the mind free from all those prejudices which tend to warp both sympathies and judgments and prevent the student from acquiring the faculty of appreciative discernment of new truths. A sharp and purely arbitrary distinction is often drawn between teaching and research, as if the two departments had nothing in common. Many persons look upon the latter as a luxury, something for which provision should be made only after every effort has been expended in teaching students how to meet the conventional restrictions imposed by examinations. The fact that this action is pretty generally accepted furnishes another instance of the relatively higher educational value placed by the general public upon the mere storing up of information than upon any effort made to develop other than the acquisitive functions of the brain. One of the chief aims of a modern education should be to cultivate in the student the spirit of a genuine love for learning. Teachers may preach this doctrine until "crack o' doom" without accomplishing as much by sermonizing as can be gained with the expenditure of less effort in giving practical demonstrations of what it is to learn. The frequent and sometimes noisy arraignments of the mental defects of college graduates made by business men not infrequently contain an element of justification, for many of the former unfortunately give evidence of having been taught to teach without first having been encouraged in their attempts to learn. The teaching not the learning spirit dominates in our American universities. In the selection of a professor the success of a teacher is too generally estimated by the ability to speak well, coin phrases, to give students their mental food in the compressed-tablet form, and in the capacity of maintaining until the end of the course a superficial, even if it be only a temporary, interest in the subject.

In the constant struggle for existence carried on by all nations it has become evident that success will crown the efforts of the people in which the brain power of its citizens has been developed to the highest state of efficiency. Any attempt to confer upon an individual the opportunities of obtaining an education is equivalent to offering him the chance of exercising the functions of the brain along the lines indicated by those who are generally without even an elementary knowledge of a very complicated organ. Rousseau fully appreciated the absurdity of expecting a professional opinion as to the functional capacity of this organ from those having only an amateur's knowledge of its anatomy

and physiology, when he suggested that physicians and not philosophers should be considered to be authorities upon educational subjects.

Thinking and behavior are phenomena dependent upon the existence of a brain and nervous system. The greatest advance in our educational system will begin when the universities require that those who assume to speak with the voice of authority upon these two important topics, shall have as thorough a knowledge as can now be obtained of the functions of the organ the development of which has alone placed us on a higher plane than that attained by our remote ancestors, the anthropoid apes. If we are sincere and earnest in our solicitations as to the hastening of the millennium where wisdom and culture shall be a common possession, let us see to it that every opportunity and encouragement is extended by the universities for the study of the methods of developing the delicate mechanism and fine balance of mind expressed in the mental qualities indicative of culture and learning. It is safe to predict that in the near future those universities will be considered the most advanced and those nations the most intelligent where the greatest encouragement is given to the study of the organ on the functional efficiency of which the advance of the human race towards a higher civilization depends. Anatole France has said the periods in which little intelligent interest has been taken in the study of the structure of the human body have corresponded with the ebbs in the advancing tide of civilization. It is no exaggeration to affirm that to-day the measure of our civilization is to be estimated by the effort made to gain a clearer and more comprehensive knowledge of the brain and its functions, with the purpose of maintaining the thinking-power of the race at its point of maximum efficiency.

The first duty of a university, we are told, is to engage in active warfare with ignorance. Over the portals of many an American institution is carved the figure of the eagle as symbolic of the spirit of the attacking forces. In too many instances, however, conditions would be better symbolized by another bird which closes its eyes to its enemies and buries its head in the sands of the deserts.

If the brain is the only organ to be used effectively in the fight against the foul fiend of ignorance, it is not creditable to American universities that they have thus far given so little attention to the proper study of the weapons to be used.

IS THE DIMINISHING BIRTH RATE VOLITIONAL?

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IT is quite generally agreed that the conditions of modern life make for a lower birth rate. But whether they make for voluntary or involuntary sterility, there is much diversity of opinion. Economists quite generally incline to the first of these views while many biologists incline to the second. Now it must be admitted at the outset that there are no statistics by which the merits of this controversy can be definitely settled. We are left, therefore, to ascertain where the probable truth lies in the light of certain considerations of a more or less general character.

I

The biologist maintains that the human organism requires a certain amount of food, clothing and shelter for the normal development of the body and to repair the wear and tear to which the varied activities of life subject it. He maintains, furthermore, that the stress of modern life is such that after other demands have been met there is often insufficient energy left for reproduction. In other words, in a fiercely competitive world the reproductive organs are undernourished until they are incapacitated to perform their special function. In accordance with the conservation of energy mental activity is said to withdraw the blood from other parts of the body with the result that the tissue of the brain is built up at the expense of other organs. The stress to which present-day conditions subject the eye is illustrative. Primitive man uses the sense of sight but sparingly, while civilized man uses it well-nigh incessantly, much of the time by lamplight, either at study, in the factory or office, or at newspaper reading on steam car or trolley until it is overtaxed. The burden thus imposed, so the biologist asserts, makes such a demand upon the fund of human energy as to interfere with the birth rate. Whether one sex is more frequently the victim of the sterilizing process than the other, there is, so far as I am aware, no consensus of opinion.

The biologist sometimes varies the preceding statement of his position by emphasizing the difficult nature of the task imposed upon the reproductive organs. So complicated is the work assigned them that it can only be successfully performed when the involuntary regulatory system is in a highly efficient condition. This regulatory system, we are told in turn, is so delicately balanced that its efficiency is frequently im-

paired by the furious rate of our business and social life. According to this view, the diminishing birth rate is not due to the under-nutrition of the reproductive organs, but rather to a breakdown in the machinery which normally controls their functioning.

In further support of his position, the biologist rests his case upon an inference. Observing that the higher animals are less prolific than the lower, he concludes that fecundity among the more advanced types of the human race is necessarily smaller than among the less advanced. Or taking his clue from the fact that wild animals when made captive become less fertile, he asserts that the industrial and social changes of the last fifty years have had a similar effect upon the human race.

Finally, the explanation of the biologist is occasionally supplemented by that of the medical expert who emphasizes the amount of involuntary sterility induced by sexual diseases. Modern transportation and the growing density of population, together with the increase of wealth and leisure, are said to spread the taint of sexual disorders by making possible more promiscuous relations between the sexes. The immoral relations which wages insufficient for self-support or for an attractive manner of dress tempt some young women to sustain are now and then mentioned as a contributory factor.

II

While conceding a certain force to the position of the biologist and the medical expert, the economist insists that it offers a far from satisfactory explanation of the phenomenon in question. Doubtless sexual diseases account for a good deal of involuntary sterility. Some authorities hold venereal diseases responsible for fully twenty-five per cent. "of the inability to procreate in man," and for more than fifty per cent. "of enforced sterility in woman, to say nothing of the one-child sterility where the conceptional capacity is absolutely extinguished with the birth of the first child." This leaves us quite in the dark, however, concerning the proportion which sterility that is involuntary is of the sum total of all kinds. More important still, there is little evidence that incapacity due to sexual diseases has become more common. The fact that existing conditions afford greater opportunity for the spread of such diseases no more proves that this has actually occurred than the increase of positions of trust proves the increase of theft. For the achievements of modern civilization are scarcely reconcilable with either the increase of dishonesty or with growing laxity in the sexual relations. Nor do the temptations incident to low wages prove that an increasing proportion of women lead lives that are impure. Certain it is that economic independence was never so consistent with chastity among women as to-day. Moreover, it is not clear that venereal diseases are most common in that portion of the popu-

lation where the birth rate is lowest. The social evil in its refined as well as in its vulgar forms is nothing new.

The economist further objects to the inference which the biologist makes from the difference in fecundity between the higher and the lower animals, or from the fact that wild animals become less fertile in captivity. The argument from analogy can easily be pushed too far. According to Malthus, the power of reproduction is less among barbarous than among civilized races.[1]

The economist also takes exception to the main contention of the biologist. Without presuming to take issue with the biologist in his own field, one may at least ask whether the decline of the birth rate has not been too sudden and marked to account for mainly in terms of a deficiency in the human organism to meet the demands made upon it. In the evolution of the race it is probable that nothing has become more firmly fixed than the power of reproduction because nothing is more necessary to survival. In fact, the persistence of procreative power is one of its noteworthy characteristics. This is so notorious among many kinds of degenerates as to call for the new science of eugenics. Apparently, the ability of the reproductive organs to take care of themselves in any competitive contest with other demands upon the human system is to be presumed. Hence, the theory that the rapid pace of life has lessened the power of fecundity to anything like the extent that the birth rate has fallen seems improbable.

Certain additional facts lend color to this position. If stress in excess of the ability of the body to appropriate nourishment impoverishes the reproductive organs, why is fecundity among the insufficiently nourished, clad and housed so great? In place of a low birth rate among the poor, quite the reverse is true. Adam Smith's oft-quoted remark that a half-starved Highland woman frequently bears more than twenty children illustrates what is a matter of common observation. On the frontier, also, the strenuous and hard conditions of life have been in no wise inconsistent with large families. Indeed, many writers attribute the diminishing birth rate to over-nutrition rather than to under-nutrition.

Again, why should the activity of the brain rather than the activity of other parts of the body interfere with the normal development and nurture of the generative organs? For what is more conducive to contentment, happiness and health than an alert and active mind. A writer in a recent number of *The American Naturalist* remarks: "An impotence ascribed to psychical causes may rarely occur, but concerning this factor, we have, obviously, little or no exact evidence."[2] In point of fact, such meager statistics as exist upon the subject indicate

[1] Marshall, "Principles of Economics," fifth edition, Vol. I., p. 184.
[2] Dr. Max Morse, "Sterility," Vol. XLIV., October, 1910, p. 624.

that the birth rate among college women who marry is practically the same as among their non-college sisters, cousins and intimate friends. Moreover, if the failure of the involuntary nervous system to work properly is responsible for the diminishing birth rate, why is not the phenomenon localized in place of diffused? Amid the quiet retreats of rural life as well as amid the rush of cities, among skilled mechanics and even among day laborers subjected to comparatively little mental or nervous strain as well as among business men and other brain workers the birth rate has fallen. The phenomenon is far more wide-spread than the explanation offered by the biologist would lead us to expect. The excessive use of the nervous system can neither cause its own undoing, or cause the under-development or atrophy of the generative organs in any considerable portion of the population.

The economist further objects to the explanations of the biologist and of the medical expert on the ground of their complexity. When asked for a bill of particulars, they are at a loss to give any reply that is at once simple and clear. The undernutrition of the reproductive organs plus the failure of the involuntary regulatory machinery to function properly offers a complex rather than a simple explanation. Moreover, the matter is still further complicated by adding the influence of sexual diseases. Besides, the argument from analogy seems a trifle fanciful. An explanation of the difference between the birth rates in France and Germany, in Germany and India, in France and French Canada, or again in the different portions of the population of any given country in terms of the will seems much more simple and clear than in terms of one or all of the several explanations offered as an alternative. The variations in the birth rate due to a scanty or an abundant harvest, or to any of the various forms of adversity and prosperity, are more readily traceable to volitional conduct than to physiological changes.

Finally, the economist objects that the biologist unwarrantedly assumes that the birth rate is determined in a purely mechanical fashion. No provision is made for the action of anything but physical and chemical forces. Elsewhere in human affairs the will guided by intelligence plays an important rôle. In so vital a matter as the birth rate, is it reasonable to absolve it from a due measure of responsibility? For the biologist rules out even a will that acts in a predetermined manner. A man enjoys a certain freedom in selecting an occupation, in spending his money, in imitating the dress of others, and in selecting his friends, but is the victim of fate as to the size of his family. Hope and fear are thus debarred from influencing the will in one of the most important domains of life. Such a view looks upon man as purely a creature of circumstances, utterly powerless to respond in any voluntary way to the forces that buffet him about. The position of the econ-

omist seems more in keeping with the general character of human nature. For man is a being with the faculty of rational prevision. No trait of civilized man is more distinctive, or more necessary to every kind of progress. Nor is there any department of life in which the exercise of foresight is more indispensable to well-being than the realm of the birth rate. Hitherto, in the formulation of public policy the attitude of moralists, publicists and statesmen has assumed the position of the economist to be correct. Clearly, he who would prove that the birth rate is in the main determined in a manner different from the results of conduct in general assumes a heavy burden. Professor Marshall says:

> In the animal and vegetable world the growth of numbers is governed by the tendency of individuals to propagate their species on the one hand, and on the other hand by the struggle for life which thins out the young before they arrive at maturity. In the human race alone the conflict of these two opposing forces is complicated by other influences. On the one hand regard for the future induces many individuals to control their natural impulses; sometimes with the purpose of worthily discharging their duties as parents; sometimes, as for instance at Rome under the empire, for mean motives. And, on the other hand, society exercises pressure on the individual by religious, moral and legal sanctions, sometimes with the object of quickening, and sometimes with that of retarding, the growth of population.[3]

III

The economist, however, does not rest his case upon merely discrediting that advanced by others. He is able to adduce evidence of two things, namely, a growing desire to limit the size of the family, and a willingness to take the steps necessary to this end, which go far toward establishing his claim that the will is the influential factor in determining the birth rate. There can be no doubt that a large family in the old sense of the word is no longer desired. The increased outlay necessary to raise a child to the age of self-support, an increase out of all proportion to the increase of incomes, in itself constitutes a good and all-sufficient reason. A much more prolonged and expensive term of training and of apprenticeship has become necessary to enter successfully upon many careers. The expense of producing self-supporting men limits their supply as truly as the expense of producing commodities. Again, the economic reasons which once rendered marriage compulsory for women have lost much of their force. The will of woman has consequently become more influential in determining not only the formation but the admission of new members to the family. The desire for ease and the fear of the birth pangs, the craving for an independent life and the desire to realize other aims inconsistent with marriage and offspring have a greater opportunity than formerly to influence the birth rate. Moreover, the keener competition to which the

[3] Marshall, *op. cit.*, p. 173.

growth of cities subjects an increasing proportion of mankind in most progressive countries may well make men hesitate about assuming the responsibility of the marriage relation. Doubtless, also, the business uncertainties and hardships to which people in cities are especially subject during trade reversals contributes to the same state of mind. Besides, the growing prevalence of democracy arouses ambitions and aspirations which enter into competition with a numerous progeny.

There is also evidence of a willingness to take the steps which these conditions demand. In the first place, marriage is postponed at the expense of the child-bearing period of woman, a fact of first importance in lessening the birth rate. It is later marriage among women rather than among men that lessens the size of the family. The postponement of marriage signifies a small increase in the proportion of women who never marry, and a large increase in the proportion who marry either at the end of the child-bearing period or when the time of greatest fertility is partially or wholly over. Later marriages among women are partly of choice and partly of necessity. So far as they are due to men, for one reason or another, proposing later, they are a matter of necessity. So far as they are due to women electing some other alternative, they are a matter of choice. In the one case the preferences of men, and in the other case the preferences of women, are decisive. In either case, however, the matter is voluntarily determined.

In the second place, steps are taken to limit the size of the family subsequent to marriage. It is not necessary for the economist to stake his case entirely upon an increase of continence, though there is little doubt that it has increased.

There are vicious measures, not here to be named in detail, which keep down the number of births or increase the number of deaths, mostly prenatal, though the infanticide of earlier times is not extinct. By strength and also by weakness, by virtue and also by vice, is the economic mandate which limits the rate of growth of population carried out.[4]

It is well known that the impediments which occasion involuntary sterility are, to some extent, within the power of medical practitioners to remove. The possibility of the contrary, namely, the "voluntary prevention of conception," is, therefore, an unavoidable inference. That this is more than a possibility appears from the fact that many members of the medical fraternity are approached much more frequently for advice by those who wish to avoid children than by those who wish to have them. This undoubtedly points to the use of "preventives" in numberless instances which escape the notice of physicians. Perhaps the chief difference between the more intelligent and the less intelligent is that the devices employed by the latter are the more crude and harmful. Among the principal causes of the diminishing birth

[4] Clark, "Essentials of Economic Theory," p. 334.

rate mentioned by a man of such extensive medical and statistical experience as Dr. John S. Billings "is the diffusion of information with regard to the subject of generation by means of popular and school treatises on physiology and hygiene, which diffusion began between thirty and forty years ago. Girls of twenty years of age at the present day know much more about anatomy and physiology than did their grandmothers at the same age, and the married women are much better informed as to the means by which the number of children may be limited than were those of thirty years ago."[5]

In a footnote of an article on "The Declining Birth Rate," Professor John B. Phillips says:

> There is certainly developing there (in Germany) the desire to reduce the size of the family. The large number of pamphlets treating of methods of preventing conception which have recently appeared and are offered for sale at the bookstores is an indication of the desire for smaller families. There is no law against the public sale of such literature in Germany. In the window of one large bookstore I counted five such pamphlets conspicuously displayed. The price of most of them was below fifty cents.[6]

Another fact which corroborates the position of the economist merits attention, namely, the birth rate is usually low at the points where we should expect. For example, a low birth rate commonly coheres with a low death rate. This holds not only between the different portions of the population of the same country, but also between the populations of different countries. Where sanitary conditions are good and the knowledge of preventive medicine most widely diffused, where the spirit of caution is most prevalent and the numberless little attentions that economize life are most unstintedly bestowed, both the birth rate and the death rate are low. On the other hand, where the reverse of these conditions obtain, both the birth rate and the death rate are high. Apparently, the same forethought safeguards both. Again, so long as the American people were mainly a nation of frontiersmen, the birth rate was high. For on the frontier the man without a wife was at an economic disadvantage and children much more than repaid for their bringing up by the time they became of age. Under these circumstances early marriages and large families were both dictated by prudence. But with the passing of the frontier and the massing of men in cities where a wife and children are often a handicap, and where the opportunities for employment open to the unmarried woman are especially attractive, the postponement of marriage and the small family become increasingly common. Under existing conditions, the highly emotional who lack self control and who are frequently without property or devoid of ambition usually marry young and have numerous children, while those in whom the deliberative

[5] *Forum*, Vol. 15, 1893, p. 475.

[6] *University of Colorado Studies*, March, 1910, p. 161.

faculty is conspicuous and who are people of substance or are highly ambitious commonly marry late and have few children. In other words, the birth rate is usually low among those in whom prudence is highly developed, and imprudence in the matter of marriage and offspring is frequently but a symptom of imprudence in other directions.

President Hadley says:

> It is true that as society exists at present, high comfort and low birth rate are commonly associated, because comfort is made to depend upon prudence. Let the comfort be made independent of prudence, as in the case of the pauper or criminal, and the birth rate tends to increase rather than diminish. It may not be exactly true, as some Malthusians would have us believe, that the low birth rate is the cause of the comfort, but it is much farther from the truth to assert that the comfort is the cause of the low birth rate. Both are the results of a common cause—the exercise of prudence, which gives high comfort and low birth rate to those who are capable of practising it, while those who are incapable of so doing have at once a higher birth rate and a lower level of comfort.[1]

IV

We recur, then, to the question propounded at the beginning, namely, is the diminishing birth rate for the most part voluntary or is it involuntary? The contention that the increasing stress of life causes sterility by impoverishing the reproductive organs, or by disturbing the involuntary regulatory system, while plausible, is open to doubt in so many respects that it is not entitled to great weight. As an explanation it is clearly inadequate. It does not account for the widespread character of the fall in the birth rate, nor does it make due allowance for the various considerations that postpone marriage and render a small family, or no family at all, desirable. Moreover, the argument from analogy is so speculative that not much need be conceded on that score. Unfortunately, the sterility due to sexual diseases can not be so easily dismissed. Even some sociologists are disposed to attribute no small part of the decreasing birth rate among the negroes to this cause, on the ground that "emancipation removed the strong economic motive of the master class to keep their slaves in good physical condition." This explanation, however, does not apply to whites. No one of course who pretends to be informed denies that venereal diseases are a fruitful cause of sterility. But when we are asked to believe that they have spread enough to account for the fall in the birth rate, we may well ask for the facts in the case. Such a supposition runs counter to progress in so many directions and to what seems to be a marked increase in the moral sensitiveness of the race. The opinion sometimes expressed that a majority of men contract venereal diseases prior to marriage may be an unwarranted generalization. The error of arguing the increase of these diseases from their known

[1] "Economics," p. 48.

prevalence in the present is also a pitfall into which it is easy to fall. Professor Willcox well says:

> It is so easy and so fallacious to argue the increase of any phenomena from the increase in the known instances. I am still unconvinced that there is any increase of insanity in the United States and my attitude is much the same regarding the diseases affecting the birth rate. At the same time I admit that the balance of expert testimony is strongly in favor of both these positions.

A final objection to the explanations offered by the biologist and the medical expert is that incapacity is to some extent a by-product of certain kinds of "preventives" that sterilize the reproductive organs. This explains why some newly wedded couples who make it a point to avoid children subsequently find that they can not have them. Of the incapacity originating outside of wedlock, also, some is undoubtedly traceable to this cause. An increase of involuntary sterility, therefore, may be merely a symptom of the increase of the voluntary variety.

The explanation of the economist, on the other hand, has the advantage of simplicity and clearness. To most minds, also, it seems less speculative than do its rivals. Besides, it comes nearer explaining the more obvious and important facts. It squares with the fact that the fall in the birth rate is not confined to any one class, and with the tendency of social phenomena, especially in a democracy, to spread throughout the rank and file of society. Moreover, a point of view that takes the will into account and does not reduce man to a mere automaton is more in harmony with the commonly accepted method of explaining social phenomena in general. The sensitiveness of the birth rate to social and economic changes is admitted by both parties to the controversy. But here the agreement ends. On the one hand, the blind response of the human organism to the environment is maintained. On the other hand, the rational response of intelligence is asserted. One emphasizes the resemblance between man and the vegetable and the animal kingdoms. The other differentiates man from other animate beings. The latter has the decided merit of recognizing what is distinctive in human nature.

Finally, the position of the economist is in keeping with certain patent and well recognized truths. One is that men act with a sense of responsibility in contracting the family relation. The general acceptance of the view that children are invited and not sent undoubtedly makes powerfully for self-restraint and social decency. The general acceptance of the contrary view would undoubtedly increase the birth rate. A second truth, and one consistent with the foregoing, is that the birth rate is well inside the physiological limit. Moreover, it is farther inside than formerly. The evidence is conclusive. First, in most countries all births, save only a small residue, occur within wedlock. Second, women marry later than formerly. This is a fact of

tremendous import. The much smaller proportion of women married in the age classes 15 to 20 and 20 to 25 in England than in India largely accounts for the difference between the birth rates in the two countries. Third, in one way and another the birth rate is to an increasing extent consciously controlled in every progressive country. Fourth, early marriages and large families have become less consistent with prudence. The expense necessary to rear children to the age of self-support has become more burdensome. Besides, the rise of other ambitions in life render both sexes more cautious about assuming the marriage relation. No theory that leaves prudential considerations out of the account can possibly explain the manner in which the social and economic changes of recent years have influenced the birth rate. Our conclusion, therefore, is that the diminishing birth rate is primarily volitional, and that the various factors which make for involuntary sterility are of minor importance.[8]

It is of interest to note that so well known a biologist as Professor H. W. Conn, of Wesleyan University, subscribes to this conclusion. He writes as follows:

> . . . I am very glad to give my opinion on this matter, recognizing that one man's opinion on this subject is of no special value except as one vote. My own opinion is that the primary reason for the diminishing birth rate is the voluntary one. The increasing demand for luxury raises the marriage age, and the same desire, together with others kindred to it, lead to the intentional and voluntary limiting the size of families. My own belief, judging from such knowledge as would come to a single individual, is that this is the greatest factor in the diminishing size of families. Indeed, I should rather be inclined to believe that if this factor could be removed we should find the race practically as fertile as in previous generations.

[8] The frequency with which economists discuss the subject of population as compared with biologists deserves a passing notice. Ever since the essay of Malthus there have been few treatises upon economics without a chapter upon the subject. Certainly, any text-book which failed to consider the matter to-day would be regarded as incomplete. A century of criticism has established a fairly consistent and satisfactory body of opinion. Moreover, the periodical literature devoted to economics has in recent years been enriched by numerous articles upon the diminishing birth rate. The American Economic and Sociological Associations have now and then discussed the subject at their annual meetings. On the other hand, there is a scarcity of literature from the biological standpoint. I do not know of any place in print where a biologist has attempted to advance a definite and complete theory of population, and in arriving at the biological explanation of the diminishing birth rate I have been dependent upon stray hints found here and there and especially upon information gained by conversation with two of my colleagues, one a zoologist and the other a botanist. There is no body of doctrine upon population to which biologists subscribe at all comparable to that among economists. In other words, the weight of well-defined opinion supports the view that the decline of the birth rate is volitional.

"RACE SUICIDE" VS. OVERPOPULATION

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ANY conscious restriction in the birth rate is popularly referred to as "race suicide." It is in this sense that Theodore Roosevelt employed the term when he wrote to Mrs. Van Vorst concerning "race suicide, complete or partial." The prevalence of a conscious restriction in the birth rate on the part of the vast majority of American families has been established beyond question, while the facts from which this conclusion is drawn form a basis for the anathema and ridicule which the opponents of a declining birth rate have heaped upon those anti-social individuals convicted of "race suicide." Paradoxical as it may seem, however, these "race murders" are in reality race saviors, for, acting in accord with the dominant evolutionary tendency of modern civilization, they are disregarding quantity and seeking to insure quality.

A continuance of the rate of increase in population which prevailed in the early nineteenth century would have resulted, in the near future of the western world, in an over-population problem as serious as that now confronting China or India. Consider, for example, the problem as it appeared in the United States. In 1800 the population of the United States was doubling itself, by natural increase, every 25 years. Had this ratio of increase continued the native-born population of 1900 would have numbered about 100,000,000, that of A.D. 2000 would have numbered 800,000,000, while the population of A.D. 2100 would have increased to 12,800,000,000 souls, or eight times the entire population of the world in 1900. The argument is thus reduced to the absurd. Such a vast population could not be adequately cared for, and some reduction of the birth rate of 1800 was therefore inevitable.

The reduction undoubtedly took place, for instead of the 100,000,000 descendants of native-born population predicted for 1900, there were but 41,000,000 in existence. The advent of the other 59,000,000 was prevented by a conscious restriction in the birth rate, made inevitable by the abnormal growth of population at the end of the eighteenth and the beginning of the nineteenth centuries.

The reduction in birth rate is clearly shown by a comparison of the United States census figures from decade to decade. From 1790 to 1800, there was little immigration, yet the population of the United States increased 35 per cent.; from 1810 to 1820 the increase was 33 per cent.; 1830 to 1840, 35 per cent.; 1850 to 1860, 35 per cent.; 1870 to 1880, 30 per cent.; and 1890 to 1900, 20 per cent. Between 1890 and 1900 the net immigration to the United States was about 2,000,000.

Deducting this number from the census increase, there remains an increase of only 18 per cent. for the native population.

The figures for England and Wales, a stable country with little immigration, shows even more clearly the abnormal increase of population after 1750. During the 270 years from 1480 to 1750 the population of England and Wales increased from 3,700,000 to 6,500,000, an increase of 2,800,000, or 75 per cent. During the next thirty years, however, from 1750 to 1780, the increase was 3,000,000 or 50 per cent. —an increase for 30 years nearly equal to the entire increase for the previous 270 years.

During the century from 1750 to 1850 the increase was from 6,500,000 to 17,600,000, an increase of 11,100,000 or 170 per cent. In the 270 years preceding 1750 the population of England and Wales increased 2,800,000, or 75 per cent.; in the 100 years following 1750 the population increased 11,100,000, or 170 per cent. The years succeeding 1750 witnessed a remarkable increase in population, an increase considerably below the rate of 1800 for the United States, but far above the rate of England for the three preceding centuries.

The chief influence in restricting the population prior to 1750 was undoubtedly exerted by the enormous death rate, for prior to that period, war, pestilence and famine played havoc with population. It is estimated that from 1618 to 1648 wars cost Germany 6,000,000 lives. The black plague in 1348–49 swept away half of the population of England. The ravages of plague may be imagined by the following death rates for England in plague years.

	Deaths per 1,000 Population
1593	240
1625	310
1636	130
1665	430

When it is remembered that modern science has reduced the death rate in some of the great cities to 15 per thousand, the significance of a death rate of 430 can be imagined. Famine played a less important part in curtailing population than either war or pestilence, but it occasionally became significant.

Any appreciable increase of population before the middle of the eighteenth century was, therefore, prevented by the high death rate, and any increase at all could be brought about only by maintaining a birth rate higher than the phenomenally high death rate. Necessity being then, as now, a kind of stepmother to invention, every device was resorted to for stimulating a higher birth rate. The injunction to "be fruitful and multiply" was accepted as a part of their religious belief and blindly followed by a great portion of the population. Statesmen looked upon prolificness as of near kin to patriotism.

While efforts were being made and effectively made to stimulate the birth rate, equally effective efforts were being directed to the reduction

of the death rate. In London the death rate from 1680 to 1728 was 80 per 1,000 of population; in 1905 it was 15; 250 years thus witnessed a decrease of more than 80 per cent. The same fact is shown by the increasing length of life of the population of Geneva, Switzerland.

In the sixteenth century	the	length	of	life	was		21.2
In the seventeenth	"	"	"	"	"	"	25.7
In the eighteenth	"	"	"	"	"	"	33.6
In the nineteenth	"	"	"	"	"	"	39.7

The gradual checking of the death rate worked a gradual increase in the length of life, and hence, unless the birth rate was proportionately checked, a corresponding increase in the population.

Thus, during the last part of the eighteenth and the early part of the nineteenth centuries, the birth rate (which remained almost unchecked) greatly exceeded the death rate (which was being effectually checked). The result of the great excess of births over deaths is shown in the tremendous increase of population after 1750—an increase which could never have been supported but for the increased production of wealth due to the development of the factory system.

The western world, at the opening of the nineteenth century, presented this significant picture—a high birth rate, a low and decreasing death rate; a phenomenal increase in population made possible by the wealth-producing power of the factory system; and big families treading close on the heels of subsistence. Here was ample justification for the pessimistic gloom of Malthus. Catastrophe seemed inevitable, when democracy entered the field, telling the men at the margin whose families were either unregulated in size or else regulated only by subsistence, that they were free and equal to every other man and had a like right to "rise." The thought was new. "How can I rise?" asked the laborer. "Stop having children," replied the economist. The advice was followed. The family of eight is replaced by the family of two and thus disencumbered of an onerous burden, the laborer is enabled to raise his standard of life.

Until 1750 any great increase in population was prevented by a high death rate. In the succeeding century, as a result of science and sanitation, the death rate was gradually reduced, and an overwhelming increase in population was prevented in only one way—by decreasing the birth rate. The decline in the birth rate therefore saved the modern civilized world from over population and economic disaster.

Conditions from 1750 to 1850 were not in stable equilibrium. The death rate had decreased; the birth rate remained high. Population, supported by the wealth of the factory system, was increasing abnormally. Malthus drew his inferences from these facts, which, if they had remained unchanged would undoubtedly have caused overpopulation. This stage was, however, merely transitory. An equilibrium of population has been reestablished through the saving grace of the decrease in the birth rate, commonly called "race suicide."

THE HEALTH INSTINCT

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"PEOPLE do not take the matter of health seriously." So wrote Professor Bain not over thirty years ago, but in the intervening time how things have changed! If he were writing on the same theme to-day, he would probably say that we take the matter of health too seriously, or, at any rate, that some of us are on the verge of so doing. We have heard of the bicycle face and the automobile countenance, and it would not be surprising if some one should soon describe for us the health-seeker's visage. It may not as yet have established itself as an unmistakable type, but one can already trace signs in a certain worn and anxious expression of countenance suggestive of the approach of starvation, or the fearsomeness of an unseen foe.

In days of old, men sallied boldly forth, fearing naught save the fires of future punishment, and these were likely to be forgotten in the business of the hour. They had too much to do, and too little to eat, to be over-anxious in regard to diet or exercise. But a knight in full armor, or a dozen of them, was as nothing to brave beside the hidden bacterial hosts which now make a constant terror by night and day; while the poison cup was rare and harmless in comparison with "auto-intoxications" and the ravages of "uric acid" with which the dweller in twentieth century time is threatened in the viands he must face each day.

Between the periods of these trying encounters with hidden foes which strike beneath the belt, the seeker after health examines with anxious eye the latest newspapers and magazines for paragraphs and articles which may serve as guides to his sad progress between the ever-threatening Scylla of overeating and the Charybdis of undereating; of exercising too much and of exercising too little. Of leading along these lines he finds no lack, but the teachers are so many and their dogmas so diverse, and the results of following their advice often so disappointing, that the health-seeker's troubles only thicken. Even those whose consciousness has given them no trouble along lines of health are not wholly exempt from the fear, or fear of the fear; for, in many households where the health idea has become rampant, the guest at the board is assailed with advice as to the wholesomeness of this, the hygienic qualities of that, and the proteid content of the other dish, until his own stomach becomes alarmed and cries out even for the flesh

pots of the Pharaohs and the jolly admonition to the banqueters to "eat, drink and be merry, for to-morrow ye die."

In the realm of muscular activity the health seeker may be told by the specialist that what he needs is more exercise, and that if he will only take a sufficient amount he will attain unto physiological perfection; while on the editorial pages of one of our dailies he reads that any exercise done in a perfunctory manner is positively harmful. One advises ten-mile walks, and another tells him that walking is the poorest of exercises. On the other hand, there is a numerous company of those who would have us attain the kingdom of health through faith rather than works. Truly, leading in the realm of the physical is as absurdly sectarian and dogmatic as it ever was in spiritual affairs. All can not be wholly right; nor all altogether wrong. Happily there is a Virgil to pilot one through the shades of half-truth expressed by the exercise cult, the chew-long circle, the low-proteid faith, or the Eddyite sisterhood. The guide is an old one—good sense—good animal sense of one's condition for work; in other words, instinct brought up to date.

From the lowest forms of life up, there are but three sets of activities, each depending on the others for its existence and condition —the consciousness of his needs, the ability to supply those needs, and the power to assimilate what has been secured. Life is but a continuous round of these, and there are no more and no less in man; the three functions are a bit more complicated, but they are at bottom the same. Among our animal ancestors each was dependent on himself, and his consciousness never failed to tell him just what and how much food to take, and how much and what kind of exercise he needed, to keep him in best fighting and hunting trim. If this consciousness (instinct) failed him, he went by the board. He took no exhausting walks to add to his energies, he knew better than to get drunk or stuff himself unnecessarily and so render himself a prey to his foes, and he had too much else to do to upset his bodily machinery by morbid introspection. Health magazines are hardly needed by a fox or a bear.

Civilization has brought with it dependence on others, and more time than the average man-animal knows what to do with. The man-child may go on a spree, knowing he will not be devoured piecemeal by his neighbors and that if he gets sick some one will take care of him, and so he goes on a spree, and so he is otherwise careless of his conduct. His instinct for health is blunted and rendered of less use through his dependence and his pleasure-of-the-moment excesses. Appetite, temporary pleasure and laziness, get the upper hand, though the consciousness of what is physically good or bad is still present and can be partially or wholly restored to controlling power. We once heard a young woman who delighted in breaking all the laws of health, remark, after hearing a lecture on the sin of disobedience to such laws,

"I do not like to hear those things; they are too true." Her health instinct was keenly alive, but only as an onlooker. Instinct was the first health law-giver, and, modified and brought to date, will always remain the supreme judge in these questions. The present widespread interest in things pertaining to diet, exercise, emotional states and other allied subjects, is an awakening of this health conscience, but we are in danger of ignoring the existence of such a guide in the anxious endeavor to follow the many one-sided teachers of the hour.

The three primitive animal functions are dependent upon each other, and so the old, old habit of doing something, of keeping busy, must be a factor, a very important factor, in the health problem. An amœba will travel faster against a current than in still water, and we have known supposed invalids gain strength and flesh under circumstances that directed their energies from thinking about their inner machinery to an outward expression of mental and physical effort of which they would have thought themselves incapable. In those with interests beyond themselves, the instinct for health has a chance to assert itself and to supervise without interference. "The chief good I do my patients," said one who is a physician to the wealthier class, "is to find some occupation for them, some hobby to keep them busy."

The application of the mind-body energies to some fixed object beyond self, arouses and sharpens one's consciousness of physical needs, and, as a result, we know what sort of eating, drinking and exercise make us feel that we are at our best each day.

The same instinctive consciousness will guide the health seeker through the maze of health teaching, and will allow him to appropriate from each doctrine its modicum of truth. If a low proteid diet clears his brain, he will reduce his proteids. If vegetables, rather than meats, bring about more power for work, he will become more or less of a vegetarian. If 3,000 calories seem better for his occupation than 1,500, he will use the former quantity. We wish that instinct could teach him not to recommend what he has found to best suit his own needs, as the best and only thing for all others.

The test, then, of low proteid and high proteid, of few calories and many calories, of an animal or vegetable diet, and of whether we need to walk ten miles a day or to lie on a couch, is the effect these things have in lifting us to our fullest capacity for physical and mental work. The one prime condition for this test is that we be physically and mentally busy as best we may in some useful and unselfish direction.

Where the instinct for health is not sufficient—and with those injured by accident or disease it can not be quite enough—the health seeker should throw the responsibility of choosing what is best for him upon one who has schooled himself for the purpose and who knows, or should know, the body-mind in order, as well as in disorder. He

should let the physician do any worrying or serious thinking that is to be done, for now-a-days that is what the physician is for. In the meanwhile he can go forward with life's daily endeavor, content with his physical limitations, and only caring to do his best.

The instinct for health can be cultivated until it is as good a guide as in the lower animals. A semi-conscious instinct, of course it is, but with our growing knowledge of health matters from day to day we can add to it, and so make it fit into our civilized manner of living.

Thinking eternally about health without making health a response to our outward striving, will as surely interfere with, or derange this guide, as the thinking about a telegraph pole will lead the learner on a bicycle to bang into it. If one thinks of the middle of the road, of whether he is up to par in his daily work, the telephone poles of dyspepsia and neurasthenia will take care of themselves; while, if listened to, the health instinct will guide him through the distracting midway of health fads without fretting because he does not find in each show all that is advertised by the barker, or just what is suited to his own particular needs. While strength is a good thing, no amount of exercising will make us all Sandows, and though chewing is important to the process of digestion, no amount of time spent in masticating food will develop in each of us the phenomenal inborn endurance of a Fletcher. It is not "in us," and it is just as well we are not all alike. All that is required of us, and all that we should require of ourselves, is that we develop our innate possibilities until we are conscious that we are at our best, our own best and not another's.

WAR AND MANHOOD[1]

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THE message I shall attempt to-day is a message of peace through the arraignment of war. My attack shall be made from the side of biology, and my text may be found in these words of Sophocles, "War does not of choice destroy bad men, but good men ever."

I shall leave to those who have had far more experience than I, the discussion of the advantages of law, order and arbitration over brute force, which decides nothing. I shall leave to one side all questions of the relations of war to social, ethical and religious development. I shall leave to others all consideration of the horrors of war, its legacies of sin, and suffering, and life-long agony. I shall not consider the costs of wars long since fought, a burden strapped for all time on the backs of the toilers of Europe. I shall not consider the cost of future wars, never to be fought, but provided for in the budget of every nation, again a burden unbearable on those whose chief relation to the life of nations is the burdens nations needlessly impose. I shall not depict the growing strength of the invisible empire of bondholders who are fast becoming the owners of the civilized world, and whose silent nod determines the issue of every great empire in war or peace.

My message concerns solely the relations of war to manhood, as shown in the succession of generations.

Benjamin Franklin once said:

> **There is one effect of a standing army which must in time be felt so as to bring about the abolition of the system. A standing army not only diminishes the population of a country, but even the size and breed of the human species. For an army is the flower of the nation. All the most vigorous, stout and well-made men in a kingdom are to be found in the army, and these men, in general, can not marry.**

What is true of standing armies is still more true of the armies that fight and fall. Those men who perish are lost to the future of civilization, they and their blood forever. For, as Franklin said again, "Wars are not paid for in war time: the bill comes later."

The last thirty years have seen the period of greatest activity in the study of biology. Among other matters, we have seen the rise of definite knowledge of the process of heredity, and its application to the formation and improvement of races of men and animals. From our

[1] Address (given in German) before the Weltcongress von Freien Christentum, Berlin, August 7, 1910.

scientific knowledge, men have developed the fine art of selective breeding. With men, as with animals, "Like the seed is the harvest." In every vicissitude of race of men or of breed of animals, it is always those who are left who determine what the future shall be.

All progress in whatever direction is conditioned on selective breeding. There is no permanent advance not dependent on advance in the type of parenthood. There is no decline except that arising from breeding from the second-best instead of the best. The rise and fall of races of men in history is, in a degree, conditioned on such elements as determine the rise and fall of a breed of cattle or of a strain of horses. As progress in blood is conditioned on normal selection or the choice of the best for parenthood, so racial decline is conditioned on reversal of selection, the choice of the worst for survival.

Always and ever, says Novicow, "war brings about the reversal of selection." These traits of character, physical strength, agility, courage, dash, patriotism, desired in the soldier, are lost in the race which decrees the destruction of the soldierly. The delusion that war in one generation sharpens the edge of warriorhood in the next generation, has no biological foundation. The man who is left determines always the future.

Once, on the flanks of the Apennines, there dwelt a race of free men, fair and strong, self-reliant and confident. They were men of courage and men of action—men "who knew no want they could not fill for themselves." "They knew none on whom they looked down, and none to whom they regarded themselves inferior." And for all things which men could accomplish, these plowmen of the Tiber and the Apennines felt themselves fully competent and adequate. "*Vir,*" they called themselves in their own tongue, and *virile, virilis,* men like them are called to this day. It was the weakling and the slave who was crowded to the wall; the man of courage begat descendants. In each generation and from generation to generation the human harvest was good. And the great wise king who ruled them; but here my story halts—for there was no king. There could be none. For it was written, men fit to be called men, men who are *Viri,* "are too self-willed, too independent, too self-centered to be ruled by anybody but themselves." Kings are for weaklings, not for men. Men free-born control their own destinies. "The fault is not in our stars, but in ourselves, that we are underlings." For it was later said of these same days: "There was a Brutus once, who would have brooked the Eternal Devil to take his seat in Rome, as easily as a king." And so there was no king to cherish and control these men his subjects. The spirit of freedom was the only ruler they knew, and this spirit being herself metaphoric called to her aid the four great genii which create and recreate nations. Variation was ever at work, while heredity held fast all that she developed. Segregation in her

mountain fastnesses held the world away, and selection chose the best and for the best purposes, casting aside the weakling, and the slave, holding the man for the man's work, and ever the man's work was at home, building the cities, subduing the forests, draining the marshes, adjusting the customs and statutes, preparing for the new generations. So the men begat sons of men after their own fashion, and the men of strength and courage were ever dominant. The Spirit of Freedom is a wise master; he cares wisely for all that he controls.

So in the early days, when Romans were men, when Rome was small, without glory, without riches, without colonies and without slaves, these were the days of Roman greatness.

Then the Spirit of Freedom little by little gave way to the Spirit of Domination. Conscious of power, men sought to exercise it, not on themselves but on one another. Little by little, this meant banding together, aggression, suppression, plunder, struggle, glory and all that goes with the pomp and circumstance of war. The individuality of men was lost in the aggrandizement of the few. Independence was swallowed up in ambition, patriotism came to have a new meaning. It was transferred from the hearth and home to the trail of the army.

It does not matter to us now what were the details of the subsequent history of Rome. We have now to consider only a single factor. In science, this factor is known as "reversal of selection." "Send forth the best ye breed!" That was the word of the Roman war-call. And the spirit of domination took these words literally, and the best were sent forth. In the conquests of Rome, *Vir,* the real man, went forth to battle and to the work of foreign invasion; *Homo,* the human being, remained on the farm and in the workshop and begat the new generations. Thus "*Vir* gave place to *Homo.*" The sons of real men gave places to the sons of scullions, stable-boys, slaves, camp-followers and the riff-raff of those the great victorious army did not want.

The fall of Rome was not due to luxury, effeminacy, corruption, the wickedness of Nero and Caligula, the weakness of the train of Constantine's worthless descendants. It was fixed at Philippi, when the spirit of domination was victorious over the spirit of freedom. It was fixed still earlier, in the rise of consuls and triumvirates and the fall of the simple, sturdy, self-sufficient race who would brook no arbitrary ruler. When the real men fell in war, or were left in far-away colonies, the life of Rome still went on. But it was a different type of Roman which continued it, and this new type repeated in Roman history its weakling parentage.

Thus we read in Roman history of the rise of the mob and of the emperor who is the mob's exponent. It is not the presence of the emperor which makes imperialism. It is the absence of the people, the want of men. Babies in their day have been emperors. A wooden image would

serve the same purpose. More than once it has served it. The decline of a people can have but one cause, the decline in the type from which it draws its sires. A herd of cattle can degenerate in no other way than this, and a race of men is under the same laws. By the rise in absolute power, as a sort of historical barometer, we may mark the decline in the breed of the people. We see this in the history of Rome. The conditional power of Julius Caesar, resting on his own tremendous personality, showed that the days were past of Cincinnatus and of Junius Brutus. The power of Augustus showed the same. But the decline went on. It is written that "the little finger of Constantine was thicker than the loins of Augustus." The emperor in the time of Claudius and Caligula was not the strong man who held in check all lesser men and organizations. He was the creature of the mob, and the mob, intoxicated with its own work, worshipped him as divine. Doubtless the last emperor, Augustulus Romulus, before he was thrown into the scrap-heap of history, was regarded in the mob's eyes and his own as the most godlike of them all.

What have the historians to say of these matters? Very few have grasped the full significance of their own words, for very few have looked on men as organisms, and on nations as dependent on the specific character of the organisms destined for their reproduction.

So far as I know, Benjamin Franklin was the first to think of man thus as an inhabitant, a species in nature among other species and dependent on nature's forces as other animals and other inhabitants must be.

In Otto Seeck's great history of "The Downfall of the Ancient World" ("Der Untergang der Antiken Welt"), he finds this downfall due solely to the rooting out of the best ("Die Ausrottung der Besten"). The historian of the "Decline and Fall of the Roman Empire," or any other empire, is engaged solely with the details of the process by which the best men are exterminated. Speaking of Greece, Dr. Seeck says, "A wealth of force of spirit went down in the suicidal wars." "In Rome, Marius and Cinna slew the aristocrats by hundreds and thousands. Sulla destroyed the democrats, and not less thoroughly. Whatever of strong blood survived fell as an offering to the proscription of the Triumvirate." "The Romans had less of spontaneous force to lose than the Greeks. Thus desolation came to them sooner. Whoever was bold enough to rise politically in Rome was almost without exception thrown to the ground. Only cowards remained and from their brood came forward the new generations. Cowardice showed itself in lack of originality and in slavish following of masters and traditions."

The Romans of the Republic could not have made the history of the Roman Empire. In their hands it would have been still a republic. Could they have held aloof from world-conquering schemes, Rome

might have remained a republic, enduring even to our own day. The seeds of destruction lie not in the race nor in the form of government, but in the influences by which the best men are cut off from the work of parenthood.

"The Roman Empire," says Seeley, "perished for want of men." The dire scarcity of men is noted even by Julius Cæsar. And at the same time it is noted that there are men enough. Rome was filling up like an overflowing marsh. Men of a certain type were plenty, "people with guano in their composition," to use Emerson's striking phrase, but the self-reliant farmers, the hardy dwellers on the flanks of the Apennines, the Roman men of the early Roman days, these were fast going, and with the change in the breed came the change in Roman history.

"The mainspring of the Roman army for centuries had been the patient strength and courage, capacity for enduring hardships, instinctive submission to military discipline of the population that lined the Apennines."

With the Antonines came "a period of sterility and barrenness in human beings." "The human harvest was bad." Bounties were offered for marriage. Penalties were devised against race-suicide. "Marriage," says Metellus, "is a duty which, however painful, every citizen ought manfully to discharge." Wars were conducted in the face of a declining birth rate, and this decline in quality and quantity of the human harvest engaged very early the attention of the wise men of Rome.

"The effect of the wars was that the ranks of the small farmers were decimated, while the number of slaves who did not serve in the army multiplied" (Bury).

Thus "*Vir* gave place to *Homo*," real men to mere human beings. There were always men enough such as they were. "A hencoop will be filled, whatever the (original) number of hens," said Benjamin Franklin. And thus the mob filled Rome. No wonder the mob-leader, the mob-hero, rose in relative importance. No wonder "the little finger of Constantine was thicker than the loins of Augustus." No wonder that "if Tiberius chastised his subjects with whips, Valentinian chastised them with scorpions."

"Government having assumed godhead took at the same time the appurtenances of it. Officials multiplied. Subjects lost their rights. Abject fear paralyzed the people and those that ruled were intoxicated with insolence and cruelty." "The worst government is that which is most worshipped as divine." "The emperor possessed in the army an overwhelming force over which citizens had no influence, which was totally deaf to reason or eloquence, which had no patriotism because it had no country, which had no humanity because it had no domestic ties." "There runs through Roman literature a brigand's and barbar-

ian's contempt for honest industry." "Roman civilization was not a creative kind, it was military, that is destructive." What was the end of it all? The nation bred real men no more. To cultivate the Roman fields "whole tribes were borrowed." The man of the quick eye and the strong arm gave place to the slave, the scullion, the pariah, the man with the hoe, the man whose lot does not change because in him there lies no power to change it. "Slaves have wrongs, but freemen alone have rights." So at the end the Roman world yielded to the barbaric, because it was weaker in force. "The barbarians settled and peopled the barbaric rather than conquered it." And the process is recorded in history as the fall of Rome.

"Out of every hundred thousand strong men, eighty thousand were slain. Out of every hundred thousand weaklings, ninety to ninety-five thousand were left to survive." This is Dr. Seeck's calculation, and the biological significance of such mathematics must be evident at once. Dr. Seeck speaks with scorn of the idea that Rome fell from the decay of old age, from the corruption of luxury, from neglect of military tactics or from the over-diffusion of culture.

It is inconceivable that the mass of Romans suffered from over-culture. In condemning the sinful luxury of wealthy Romans, we forget that the trade-lords of the fifteenth and sixteenth centuries were scarcely inferior in this regard to Lucullus and Apicius, their waste and luxury not constituting the slightest check to the advance of the nations to which these men belonged. The people who lived in luxury in Rome were scattered more thinly than in any modern state of Europe. The masses lived at all times more poorly and frugally because they could do nothing else. Can we conceive that a war force of untold millions of people is rendered effeminate by the luxury of a few hundreds?

Too long have historians looked on the rich and noble as making the fate of the world. Half the Roman Empire was made up of rough barbarians untouched by Greek or Roman culture. (Seeck.)

Whatever the remote and ultimate cause may have been, the immediate cause to which the fall of the empire can be traced is a physical not a moral decay. In valor, discipline and science the Roman armies remained what they had always been and the peasant emperors of Illyricum were worthy successors of Cincinnatus and Caius Marius. But the problem was, how to replenish those armies. Men were wanting. The empire perished for want of men. (Seeley.)

Does history ever repeat itself? It always does if it is true history. If it does not we are dealing not with history, but with mere succession of incidents. Like causes produce like effects, just as often as man may choose to test them. Whenever men use a nation for the test, poor seed yields a poor fruition. Where the weakling and the coward survive in human history, there "the human harvest is bad," and it can never be otherwise.

The finest Roman province, a leader in the Roman world, was her colony of Hispania. What of Spain in history? What of Spain to-day? "This is Castile," said a Spanish writer, "she makes men and

wastes them." "This sublime and terrible phrase," says another writer, "sums up Spanish history."

In 1630, according to Captain Calkins, the Augustinian friar, La Puente, thus summed up the fate of Spain:

> Against the credit for redeemed souls, I set the cost of armadas and the sacrifice of soldiers and friars sent to the Philippines. And this I count the chief loss: for mines give silver and forests give timber, but only Spain gives Spaniards, and she may give so many that she may be left desolate and constrained to bring up strangers' children instead of her own.

Another of the noblest of Roman provinces was Gallia, the favored land, in which the best of the Romans, the Franks and the Northmen, have mingled their blood to produce a nation of men, hopefully leaders in the arts of peace, fatally leaders also in the arts of war.

In that clever volume of his, Demolins asks: "In what constitutes the superiority of the Anglo-Saxon?" Before we answer this, we may ask, "In what constitutes the inferiority of races not Anglo-Saxon?" If we admit that inferiority exists in any degree, may we not find in the background the causes of the fall of Greece, the fall of Rome, the fall of Spain? We find the spirit of domination, the spirit of glory, the spirit of war, the final survival of subserviency, of cowardice and of sterility. The man who is left holds in his grasp the history of the future. The evolution of a race is always selective, never collective. Collective evolution among men or beasts, the movement upward or downward of the whole as a whole, irrespective of training or selection, does not exist. As Lepouge has said, "It exists in rhetoric, not in truth nor in history."

The survival of the fittest in the struggle for existence is the primal moving cause of race progress and of race changes. In the red stress of human history, this natural process of selection is sometimes reversed. A reversal of selection is the beginning of degradation. It is degradation itself. Can we see the fall of Rome in any part of the history of modern Europe? Let us look again at the history. A single short part of it will be enough. It will give us the clue to the rest.

In the Wiertz gallery in Brussels is a wonderful painting, dating from the time of Waterloo, called Napoleon in Hell. It represents the great marshal with folded arms and face unmoved descending slowly to the land of the shades. Before him, filling all the background of the picture with every expression of countenance, are the men sent before him by the unbridled ambition of Napoleon. Three millions and seventy thousand there were in all—so history tells us—more than half of them Frenchmen. They are not all shown in one picture. They are only hinted at. And behind the millions shown or hinted at are the millions on millions of men who might have been and are not—the huge widening human wedge of the possible descendants of the men who

fell in battle. These men of Napoleon's armies were the youth without blemish, "the best that the nation could bring," chosen as "food for powder," "ere evening to be trampled like the grass," in the rush of Napoleon's great battles. These men came from the plow, from the work-shop, from the school, the best there were—those from eighteen to thirty-five years of age at first, but afterwards the older and the younger. "A boy will stop a bullet as well as a man"; this maxim is accredited to Napoleon. "The more vigorous and well born a young man is," says Novicow, "the more normally constituted, the greater his chance to be slain by musket or magazine, the rifled cannon and other similar engines of civilization." Among those destroyed by Napoleon were "the elite of Europe." "Napoleon," said Otto Seeck, "in a series of years seized all the young of high stature and left them scattered over many battle fields, so that the French people who followed them are mostly men of smaller stature. More than once in France since Napoleon's time has the military limit been lowered."

Says Le Goyt, "It will take long periods of peace and plenty before France can recover the tall statures mowed down in the wars of the republic and the first empire."

I need not tell again the story of Napoleon's campaigns. It began with the justice and helpfulness of the Code Napoleon, the prowess of the brave lieutenant whose military skill and intrepidity had caused him to deserve well of his nation.

The spirit of freedom gave way to the spirit of domination. The path of glory is one which descends easily. Campaign followed campaign, against enemies, against neutrals, against friends. The trail of glory crossed the Alps to Italy and to Egypt, crossed Switzerland to Austria, crossed Germany to Russia. Conscription followed victory and victory and conscription debased the human species. "The human harvest was bad." The first consul became the emperor. The servant of the people became the founder of the dynasty. Again conscription after conscription. "Let them die with arms in their hands. Their death is glorious, and it will be avenged. You can always fill the places of soldiers." These were Napoleon's words when Dupont surrendered his army in Spain to save the lives of a doomed battalion.

More conscription. After the battle of Wagram, we are told, the French began to feel their weakness, the Grand Army was not the army which fought at Ulm and Jena. "Raw conscripts raised before their time and hurriedly drafted into the line had impaired its steadiness."

On to Moscow,[2] "amidst ever-deepening misery they struggled on, until of the 600,000 men who had proudly crossed the Niemen for the conquest of Russia, only 20,000 famished, frost-bitten, unarmed spectres staggered across the bridge of Korni in the middle of December."

"Despite the loss of the most splendid army marshalled by man,

[2] These quotations are from the "History of Napoleon," I., by J. H. Rose.

Napoleon abated no whit of his resolve to dominate Germany and discipline Russia. . . . He strained every effort to call the youth of the empire to arms . . . and 350,000 conscripts were promised by the Senate. The mighty swirl of the Moscow campaign sucked in 150,000 lads of under twenty years of age into the devouring vortex." "The peasantry gave up their sons as food for cannon." But "many were appalled at the frightful drain on the nation's strength." "In less than half a year after the loss of half a million men a new army nearly as numerous was marshalled under the imperial eagles. But the majority were young, untrained troops, and it was remarked that the conscripts born in the year of Terror had not the stamina of the earlier levies. Brave they were, superbly brave, and the emperor sought by every means to breathe into them his indomitable spirit." "Truly the emperor could make boys heroes, but he could never repair the losses of 1812." "Soldiers were wanting, youths were dragged forth." The human harvest was at its very worst.

The unfailing result of this must be the failure in the nation of those qualities most sought in the soldier. The result is a crippled nation, "Une nation blessée," to use the words of an honored professor in the University of Paris. The effect would not appear in the effacement of art or science, or creative imagination. Men who lead in these regards are not drawn by preference or by conscription to the life of the soldier. If we cut the roots of a tree, we shall not affect, for a time at least, the quality of its flowers or its fruits. We are limiting its future, rather than changing its present. In like manner does war affect the life of nations. It limits the future, rather than checks the present.

Those who fall in war are the young men of the nations, the men between the ages of eighteen and thirty-five, without blemish so far as may be—the men of courage, alertness, dash and recklessness, the men who value their lives as nought in the service of the nation. The man who is left is for better and for worse the reverse of all this, and it is he who determines what the future of the nation shall be.

However noble, encouraging, inspiring, the history of modern Europe may be, it is not the history we should have the right to expect from the development of its racial elements. It is not the history that would have been made by these same elements released from the shadow of the reversed selection of fratricidal war. And the angle of divergence between what might have been and what has been, will be determined by the percentage of strong men slain on the field of glory.

And all this applies, not to one nation nor to one group of nations alone, but in like degree to all nations, which have sent forth their young men to the field of slaughter. As with Greece and Rome, as with France and Spain, as with Mauritania and Turkestan, so with Germany and England, so with all nations who have sent forth "the best

they breed" to the foreign service, while cautious, thrifty mediocrity filled up the ranks at home.

In his charming studies of "Feudal and Modern Japan," Mr. Arthur Knapp, of Yokohama, returns again and again to the great marvel of Japan's military prowess after more than two hundred years of peace. This was shown in the Chinese war. It has been more conclusively shown on the fields of Manchuria since Mr. Knapp's book was written. It is astonishing to him that, after more than six generations in which physical courage has not been demanded, these virile virtues should be found unimpaired. We can readily see that this is just what we should expect. In times of peace there is no slaughter of the strong, no sacrifice of the courageous. In the peaceful struggle for existence there is a premium placed on these virtues. The virile and the brave survive. The idle, weak and dissipated go to the wall. "What won the battles on the Yalu, in Korea or Manchuria," says the Japanese, Nitobe, "was the ghosts of our fathers guiding our hands and beating in our hearts. They are not dead, these ghosts, those spirits of our warlike ancestors. Scratch a Japanese, even one of the most advanced ideas, and you will find a Samurai." If we translate this from the language of Shintoism to that of science we find it a testimony to the strength of race-heredity, the survival of the ways of the strong in the lives of the self-reliant.

If after two hundred years of incessant battle Japan still remained virile and warlike, that would indeed be the marvel. But that marvel no nation has ever seen. It is doubtless true that warlike traditions are most persistent with nations most frequently engaged in war. But the traditions of war and the physical strength to gain victories are very different things. Other things being equal, the nation which has known least of war is the one most likely to develop the "strong battalions" with whom victory must rest.

As Americans we are more deeply interested in the fate of our mother country than in that of the other nations of Europe.

What shall we say of England and of her relation to the reversed selection of war?

Statistics we have none, and no evidence of tangible decline that Englishmen will not indignantly repudiate. When the London press in the vacation season fills its columns with editorials on English degeneration, it is something else to which these journalists refer. Their problem is that of the London slums, of sweat-shops and child-labor, of wasting overwork and of lack of nutrition, of premature old age and of sodden drunkenness—influences which bring about the degeneration of the individual, the inefficiency of the social group, but which for the most part leave no trace in heredity and are therefore no factor in the degeneration of the race. Such degradation is at once cause, effect

and symptom—a sign of racial inadequacy, a cause of further enfeeblement and an effect of unjust and injurious social, political and industrial conditions in the past.

But the problem before us is not the problem of the slums. What mark has been left on England by her great struggles for freedom and by the thousand petty struggles to impose on the world the semblance of order called "Pax Britannica," the British peace?

To one who travels widely through the counties of England some part of the cost is plain.

> There's a widow in sleepy Chester
> Who mourns for her only son;
> There's a grave by the Pabeng River—
> A grave which the Burmans shun.

This is a condition repeated in every village of England, and its history is recorded on the walls of every parish church. Everywhere can be seen tablets in memory of young men—gentlemen's sons from Eton and Rugby and Winchester and Harrow, scholars from Oxford and Cambridge, who have given up their lives in some far-off petty war. Their bodies rest in Zululand, in Cambodia, in the Gold Coast, in the Transvaal. In England only they are remembered. In the parish churches these records are numbered by the score. In the cathedrals they are recorded by the thousand. Go from one cathedral town to another—Canterbury, Winchester, Chichester, Exeter, Salisbury, Wells, Ely, York, Lincoln, Durham, Litchfield, Chester (what a wonderful series of pictures this list of names calls up!), and you will find always the same story, the same sad array of memorials to young men. What would be the effect on England if all of these "unreturning brave" and all that should have been their descendants could be numbered among her sons to-day? Doubtless not all of these were young men of character. Doubtless not all are worthy even of the scant glory of a memorial tablet. But most of them were worthy. Most of them were brave and true, and most of them looked out on life with "frank blue Briton eyes."

This too we may admit, that war is not the only destructive agency in modern society, and that in the struggle for existence the England of to-day has had many advantages which must hide or neutralize the waste of war.

It suggests the inevitable end of all empire, of all dominion of man over man by force of arms. More than all who fall in battle or are wasted in the camps, the nation misses the "fair women and brave men" who should have been the descendants of the strong and the manly. If we may personify the spirit of the nation, it grieves most not over its "unreturning brave," but over those who might have been but never were, and who, so long as history lasts, can never be.

It is claimed that by the law of probabilities as developed by Quetelet, there will appear in each generation the same number of potential poets, artists, investigators, patriots, athletes and superior men of each degree. But this law has no real validity. Its pertinence involves the theory of continuity of paternity, that in each generation a percentage practically equal of men of superior force or superior mentality should survive to take the responsibilities of parenthood. Otherwise Quetelet's law becomes subject to the operation of another law, the operation of reversed selection, or the biological "law of diminishing returns." In other words, breeding from an inferior stock is the sole agency in race degeneration, as selection natural or artificial along one line or another is the sole agency in race progress.

And all laws of probabilities and of averages are subject to a still higher law, the primal law of biology, which no cross-current of life can overrule or modify: Like the seed is the harvest.

And because this is true, arises the final and bitter truth: "Wars are not paid for in war time. The bill comes later!"

THE PROGRESS OF SCIENCE

ACADEMIC AND INDUSTRIAL EFFICIENCY

THE Carnegie Foundation is certainly doing what it can to disturb the somnambulance which is supposed to characterize academic circles. It promises length of service pensions to professors and then decides not to pay them; its trustees pass resolutions and quite different action is announced in the annual report; it tells universities to do this, that and the other, if they want its pensions. There was recently published a report informing us that most of the medical schools in the country should be suppressed, and we now have a bulletin telling us how universities should introduce the industrial efficiency which the author optimistically assumes to characterize our manufacturing concerns.

This publication, like others from the same source, is really interesting. It is an advantage for academic problems to be discussed from all sides and that complete publicity should be given to financial management. It is, however undesirable for an institution having largesses to bestow to assume powers either inquisitorial or dictatorial. In the present case it is fair to state that the president of the foundation says that he refrains from discussing the merits of the report made and published under its direction.

The author, Mr. M. L. Cooke, is an engineer who specializes in the organization and management of industrial establishments. He takes himself and his methods so seriously that it is difficult to treat them with the consideration which they may deserve. It is evident from the principle of the "cost per unit hour" that a university in which a thousand-dollar instructor is teaching a hundred students is five hundred times as efficient as one in which a five-thousand-dollar professor is proposing a problem for research to a single man; but it is not clear how one can deduce from this principle that "there is a distinct disadvantage to undergraduate students to be near research work." But perhaps this is because research work does not set an example of efficiency, the universities not yet having adopted Mr. Cooke's plan of a "general research board" and "a director of research," "to pass on the expediency of undertaking any given project, and to keep constant track of the progress of work and of its cost."

Mr. Cooke commends one professor who told him "that if at a lecture the students began to get drowsy, he gave them a little more air," but it is not clear that the cost per unit hour would have been increased if the air had been let in sooner. This particular professor is also highly praised for keeping his lecture-room extraordinarily neat; but it appears elsewhere in the report that under these circumstances he required four assistants to help in the preparation of a lecture.

We are told by Mr. Cooke that only at one university "was there anything to impress me with the snap and vigor of the business administration." If the tables in the report are correct, this university pays its teachers less than Harvard, but spends more than twice as much in its administration, namely, $258,456.12 a year, about half what it pays its teachers. This university, the combined cost of whose administration and teaching is greater than at Harvard, has about half as many scientific men of distinction on its faculty. Indeed, in one case at least Mr. Cooke's observation is not bad, for he naïvely says: "At those schools where there were the largest

number of "big men" I found what seemed to me to be the least desirable systems of management." Mr. Cooke would remedy this by arranging matters so "that when a man has ceased to be efficient he must be retired, as he would in any other line of work"; but he does not tell us who would be responsible for dismissing professors or whether under these circumstances professors in our leading universities might not properly expect salaries equal to those of our leading engineers, physicians and lawyers.

It should be understood that these remarks and quotations give only one side of Mr. Cooke's report, which is in many respects a document worth reading. The usefulness of our universities should be increased; their money is not always spent to the best advantage. It seems to be generally true that efficiency is inversely as the size of the "concern." The writer of this note has recently had dealings with a department store, a publishing house and an express company, and he can assure Mr. Cooke and the Carnegie Foundation that there is even more urgent need for missionary labors on behalf of efficiency elsewhere than in the university. Efficiency is desirable everywhere; but it is only a means to an end. The university stands for higher things—scholarship, research, service, leadership, ideals, honor. It is doubtful whether the further elaboration of department-store methods in the university will even reduce the "cost per unit hour," if "overhead charges" are included. The solution is the reverse of that proposed by Mr. Cooke. The department should have autonomy and the individual freedom. Only thus will the best men be drawn to the universities and be led to do their best work.

THE MOUNT WILSON CONFERENCE OF THE SOLAR UNION

THE fourth conference of the International Union for Solar Research was held at the Solar Observatory of the Carnegie Institution, Mount Wilson, California, from August 31 to September 2, 1910. The attendance was large, 37 delegates from eleven foreign countries being recorded on the official list, together with 46 Americans. Many of the latter, though not members of the union, had accepted its invitation to attend the conference.

Nearly half the delegates crossed the continent together, as many had attended the meeting of the Astronomical and Astrophysical Society of America at Harvard (August 17–19). This afforded opportunities for informal conferences and discussions almost equal in value to those provided by the conference itself.

On Monday, August 29, the members of the conference visited the laboratories and shops of the Solar Observatory, which are in Pasadena at the foot of the mountain. Among the things of greatest interest may be mentioned the exceedingly well-equipped spectroscopic laboratory, the massive machinery for grinding the great 100-inch mirror and a wealth of photographs, some of which showed the enormous light-gathering power of the great 60-inch reflector now installed on the mountain.

The afternoon was pleasantly occupied by a garden party given by Professor and Mrs. Hale, and on the following morning the party, numbering nearly 100, began the 5,000-foot climb to the observatory, some in carriages, some on horseback and a few hardy souls on foot. The hotel on the summit, though crowded to the limit, provided all with very comfortable accommodation.

No formal papers were read at the sessions of the conference, which were devoted to the reports of committees and to questions of general policy; but the larger part of the day was free for conferences of an informal nature, which were most valuable, especially to the younger men.

The first official session was on Wednesday morning. Professors Pick-

ering, Campbell and Frost (directors of the Harvard, Lick and Yerkes observatories) were elected chairmen for the three days of the meeting, and Messrs. Puiseux (of Paris), Konen (Münster) and Adams (Mt. Wilson), secretaries of the meeting. All formal business was announced in English, French and German, and the three languages were used in the discussions, which emphasized the international character of the gathering.

Dr. Hale made the opening address. He welcomed the visitors to the observatory, and described the work in progress there, dwelling especially on the recent discoveries that sun-spots are the centers of a vortical movement in the upper layers of the solar atmosphere, and the seat of strong magnetic fields, and describing the new "tower telescope," of 150 feet focal length, mounted vertically on a tower, every member of whose framework is completely surrounded by that of an outer tower, protecting it from vibration and other disturbances, while the spectroscopic apparatus, of 75 feet focal length, is in a deep well under the tower, effectually protected from changes of temperature and other perturbations.

The report of the committee on standard wave-lengths was presented by Professor Kayser (Bonn), and it was voted that when three independent measurements by the interference method of the lines of the iron arc are available, the arithmetical mean of the three shall be adopted as international standards of the second order (Michelson's determination for the red cadmium line being the primary standard). Standards of the third order are to be determined by interpolation between these and a complete system of very exact reference points throughout the spectrum thereby obtained.

Dr. Abbot, of the Smithsonian Astrophysical Observatory on Mount Wilson, lectured that evening on the solar constant of radiation, and presented a committee report dealing with the same subject on the following morning. After correcting for the absorption of heat in passing through our atmosphere (a very difficult problem, now in a fair way toward solution) the heat received from the sun appears to be slightly less than two gram-calories per square centimeter per minute. The Mount Wilson observations, however, show changes of short and irregular period (a few days) which exceed the errors of observation. It is exceedingly desirable to establish a second station some distance away (say in Mexico) where simultaneous observations may be made, to determine whether these changes are of solar or atmospheric origin.

The report of the committee on the spectra of sun-spots was presented by Professor Fowler (South Kensington). The principal feature of interest was the remarkable constancy, even in small details, of the spectrum shown by different spots.

On the second evening (Thursday) Professor Kapteyn (Groningen) lectured on "Star-streams among Stars of the Orion Type," showing that in a large region of the southern sky (including Scorpio, Centaurus and the Southern Cross) 85 per cent. of the stars of this spectral type (supposed to be the hottest) are moving together in space, their actual motions being very nearly equal and parallel; while in Perseus and neighboring constellations 95 per cent. of the stars of the same type have a similar common drift, but of different magnitude and direction. The velocity of these drifts can be found from spectroscopic observations, which makes it possible to determine the distances of these remote stars, which in some cases appear to be as great as 500 light-years—far beyond the possibility of direct measurement.

On Friday reports from committees on solar rotation and on spectroheliographic work were presented, and, the regular business being at an end, the question of the extension of the work

ASTRONOMERS ON MOUNT WILSON

Dr. Hale near the center; on his left Mrs. Kapteyn and Mrs. Fleming; on his right Messrs. Pickering, Backlund, Kayser and Turner; further on, Messrs. Rydberg, Wolfer, Küstner, Hartmann, Puiseux and Frost. Above, near the door, are Messrs. Ames, Kosen, Fowler, Deslandres, Belopolsky, Campbell, Ricco, Schwarzschild and Schlesinger. Further to the left are Messrs. Fabry, Hills, Abbot, Larmor, Dyson, Barnard, Newell and Pringsheim.

of the union to the study of stellar spectra was discussed at some length. Opinion in favor of such a step appeared to be almost unanimous, and, on motion of Professor Schwarzschild (Potsdam), it was formally resolved "that the Solar Union extend its sphere of activity so as to include astrophysics generally," and this was followed up by the appointment of a committee on the classification of stellar spectra.

Invitations to hold the next meeting at Bonn, Barcelona and Rome were presented, and it was decided to meet at the first, in the summer of 1913—the exact date to be determined by the executive committee.

The former committees of the union were in most cases reappointed, a number of new members being added. The new committee on stellar spectra includes Messrs. Pickering (chairman), Adams, Campbell, **Frost, Hale, Hamer,** Hartmann, Kapteyn, **Küstner, Newall,** Plaskett, Russell, Schlesinger (secretary) and Schwarzschild, with power to add to their number.

Resolutions of thanks—proposed in very felicitous speeches—completed the business, and the conference adjourned, to reassemble on Saturday evening at Pasadena as the guests of Dr. and Mrs. Hale at a dinner, which brought the proceedings to a close.

The only cloud upon an otherwise flawless week was the ill-health of Dr. Hale, who was able to attend only the opening session of a conference whose success was above all things the result of his hospitable preparations.

SCIENTIFIC ITEMS

WE record with regret the deaths of Dr. Charles Otis Whitman, head of the department of zoology of the University of Chicago and lately director of the Woods Hole Marine Biological Station; of Dr. Christian Archibald Herter, professor of pharmacology and therapeutics in the College of Physicians and Surgeons of Columbia University; of Dr. Octave Chanute, of Chicago, known for his important contributions to scientific aviation, and of Dr. Angelo Mosso, professor of physiology in the University of Turin.

A MEMORIAL has been erected at the National Bacteriological Institute in the City of Mexico to Howard T. Ricketts, who at the time of his death was assistant professor of pathology in the University of Chicago and professor-elect of pathology in the University of Pennsylvania. His death was caused by typhus fever, which he contracted while conducting researches in this disease.

DR. EDGAR F. SMITH, for twenty-two years professor of chemistry in the University of Pennsylvania and for twelve years vice-provost, has been elected provost in succession to Dr. C. C. Harrison.—Mr. R. A. Sampson, F.R.S., professor of mathematics and astronomy in the University of Durham, has been named astronomer royal for Scotland in succession to Mr. F. W. Dyson, F.R.S.

AT the celebration of the centenary of the University of Berlin degrees were conferred on three American men of science—the degree of doctor of philosophy on Dr. George E. Hale, director of the Mount Wilson Solar Observatory, and on Dr. Bailey Willis, of the U. S. Geological Survey, and the degree of doctor of medicine and surgery on Dr. Theodore W. Richards, professor of chemistry in Harvard University.—Dr. Henry F. Osborn, of Columbia University and the American Museum of Natural History, and Professor E. B. Wilson, of Columbia University, have been elected corresponding members of the Munich Academy of Sciences.—Mme. Curie is a candidate for the *fauteuil* at the Academy of Sciences, rendered vacant by the death of M. Gernez.